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NEW YORK UNDERGROUND RAPID TRANSIT RAILway affairs continue in an uncertain state. On Jan. 25 the successful bidder for the contract, Mr. John B. McDonald, of New York, requested from the Rapid Transit Commission an extension of time in which to qualify. The terms of qualification required, as stated in our last issue, are that the contractor must deposit $1,000,000 in cash, a $1,000,000 continuing bond, and a $5,000,000 construction bond. One reason for the delay which has been requested, is stated to be that the various surety companies have demanded what Mr. McDonald claims to be an exorbitant fee for guaranteeing the two bonds, aggregating $6,000,000, and he requires more time to adjust matters with the surety companies or to secure bonds elsewhere. Another reason given is that the surety companies object to bonding an individual for such great sums for so long a period of time owing to the complications which would arise in case of his death. They are willing, however, to give such bonds for a construction company whose life, of course, continues even should the principal member die. It is now stated that a construction company will be formed and that its financial affairs will be in the hands of the banking house of August Belmont & Co., of New York city. The bill to amend the original rapid transit act so that the City Comptroller may issue the bonds for construction without the concurrence of the New York Municipal Assembly, has passed the New York Legislature. This bill must be approved by the Mayor of New York city and signed by the Governor of the State before it becomes a law.

LAND DAMAGES FOR THE TWO EAST RIVER Bridges proposed to be constructed by the Department of Bridges of New York city will reach very high figures, according to the maps which have recently been published by the Department to show the land which has been marked out for condemnation for the approaches. As previously stated in these columns, one of the proposed bridges, known as the Third East River Bridge, will be located about a quarter of a mile east of the present Brooklyn Bridge, and the other, known as the Fourth East River Bridge, will cross Blackwell's Island at about 70th St. The estimated cost of these bridges as originally given out by the Department was as follows:

	Third Bridge.	Fourth Bridge.
Cost of main structure....	$9,522,000	$9,400,000
Land for approaches.....	6,281,000	3,148,500
Total estimated cost.....	$15,833,600	$12,548,500

These figures for land damages are justly criticised as being two small. According to the map published, the land marked out for condemnation for the Third Bridge approaches comprises a strip 160 ft. wide and 2,610 ft. long on the New York side of the river, and a strip 160 ft. wide and 5,800 ft. long on the Brooklyn side. These two areas comprise 475 separate parcels of property in the most thickly built up sections of the two cities. Newspaper estimates, based upon the assessed valuation of this property for the present year, place its cost to the city for bridge approaches at from $9,000,000 to $10,000,000. Individual estimates in several instances raise these totals to $15,000,000. The Blackwell's Island bridge is 7,636 ft. long, of which 2,500 ft. are across the river channels and the island, and the remaining 5,086 ft. are comprised in the two short inshore spans and the approaches. Owing to the comparatively low cost of land at this location the land damages will be considerably smaller than for the Third Bridge, but a conservative estimate places it at at least twice the sum estimated by the Department of Bridges, or about $6,300,000.

THE PARIS METROPOLITAN ELECTRIC RAILWAY, or one of the six lines that will eventually form that system, is approaching completion. This part extends in almost a straight line through the center of the city, from the Port de Vincennes to the Port de Maillot, at the entrance to the Bois de Boulogne, a length of 6¼ miles, with its main portion parallel to the Seine. There are also two branch lines, from the Place de l'Etoile to Porte Dauphine, and to the Trocadero Palace, adding 2¼ miles to the above total. This section, commenced in March, 1898, is estimated to cost $7,500,000. It is an underground system, with some elevated sections, with double track of standard gage; and the general method of construction adopted is to build separately the abutments in trenches; lay plate-girders spanning the two tracks slightly below below the street surface, and finally to excavate the soil beneath these girders and the floor system supported by them. The City of Paris is building the road, and will control the operating. The law of 1898 requires 26 miles of double track to be opened within eight years from that time, and the whole system must be open in 13 years. Each train must carry at least 100 passengers; running at 2 to 4 minutes intervals at 12.4 to 22.3 miles per hour. A first-class ticket will cost 5 cts. and a second-class 3 cts.; and by paying 1 ct. extra on a second-class ticket bought before 9 a. m. a passenger is entitled to a return ticket good for any time up to midnight of that day.

ELECTRIC RAILWAYS IN HAWAII are proposed by a syndicate represented by L. P. Matthews, of Cleveland, O. It is reported that $5,000,000 may be expended in the enterprise, as plans perfected call for 310 miles of electric lines, in and around Honolulu and elsewhere on Oahu Island. The ties and lumber will come from Puget Sound.

THE TALIENWAN-NEWCHWANG RAILWAY, says the "China Gazette" of Dec. 11, 1899, was completed about Dec. 1, and trains are now running over its length of nearly 200 miles. This line connects Newchwang, Port Arthur and Talienwan, and was constructed by the Russians. It shows signs of being hastily built, and high speed is prohibited, says the "Gazette." The line from Newchwang to Moukden is now working; and, as Russia still declares that it is her intention to keep Talienwan open as a "free port," this railway opens up a new and important route to the commerce of Manchuria and Northern China.

THE SARATOV-TCHARJUI RAILWAY, suggested by the Russian Minister of Ways of Communication, would start at Saratov, in the valley of the Volga, pass between the Aral and the Caspian Seas, and down the River Amu Daria to Tcharjui, in Bokhara; and ultimately connect with the British-Indian railway systems, making an all-rail route from Europe to India. The estimated cost of the line would be 90,000,000 rubles. The inner purpose of the route suggested would be to destroy the economic value of the Anglo-German railway through Persia, the late concessions for which endangers the ultimate access of Russia to the Persian Gulf. The Anglo-German route lies through Asia Minor and Syria to Bagdad, to connect later with India by a line through Southern Persia and Beluchistan. The Russian Minister believes that by the Volga line he could provide a much better and shorter route to India and thus kill the proposed extension of the rival line.

SIMPLON TUNNEL PROGRESS is reported to Dec. 12, 1899, by U. S. Consul A. L. Frankenthal, of Berne. Work was commenced on this 12.4-mile tunnel on Nov. 13, 1898, and the contract calls for completion in 5½ years, for $13,413,500. As compared with this tunnel the St. Gothard is 9.3 miles long, and the Mt. Cenis is 8 miles long. The driving of the Simplon tunnel was in charge of Engineer Brandt, whose hydraulic rotary drills are used. Two parallel headings are being constructed; one of which will carry a single track, and by cutting down the intervening wall, a double-track tunnel can be obtained at some later time. These two headings are connected at intervals of 656 ft., and by means of powerful air currents forced into one heading and returning by the other the tunnel is ventilated; the heated air inside is also cooled by spraying with water under high pressure. To Dec. 1, 1899, 3,374 m., or about 2⅛ miles of the tunnel were completed; or, 2,148 m. on the north, and 1,426 m. on the south side. During the month of November, with 10 days lost by a strike among the workmen, a progress was made of 478 ft. on the south side, and 404 ft. on the north side. Mr. Brandt died on Nov. 22, 1899.

THE CASCADE TUNNEL on the Great Northern Ry. is expected to be completed in a few months. The total length will be 2½ miles, and on Jan. 24 only 3,700 lin. ft. remained to be driven, so that at the rate of progress which has been made for the past few months, it is expected to have the heading driven through in August. About 750 men are at work, and the progress averages 10 ft. per day at each end. The tunnel is 2,300 ft. below the mountain peak, and it will cost about $3,000,000.

THE MOST SERIOUS RAILWAY ACCIDENT of the week, and a most remarkable one, occurred on the New Jersey Central R. R., at Ashley, Pa., on Jan. 25. A freight train became uncontrollable and dashed down a step mountain grade into the Ashley yards, where it collided successively with two yard engines. At the second collision, 25 tons of dynamite, carried on one of the cars, exploded, wrecking structures of all kinds in the neighborhood. The roundhouse was completely demolished, together with all engines and cars standing in the yards. The loss includes six locomotives and 70 cars and amounts to over $1,500,000. Six men were killed and eight badly injured.

THE PURCHASE OF THE NEW WATER SUPPLY Works for Jersey City under the contract between that city and Patrick H. Flynn, will be submitted to popular vote on Feb. 13. The contract price is $7,595,000, for gravity works capable of delivering 50,000,000 gallons a day to one of the present reservoirs of the city under a head at the point of delivery equal to an elevation of 210 ft.

BIDS FOR FOUR 30,000,000-GALLON PUMPING ENGINES will be received until March 9 by the Commissioners of Water-Works of the city of Cincinnati; also for boilers to supply steam to the plant and for an electric crane of not less than 30 tons capacity. The pumping engines will be of the self-contained, vertical, triple-expansion, crank-and-fly-wheel type. The whole plant is to replace one called for by a contract made Jan. 4, 1898, with the Lane & Bodley Co., of Cincinnati, for $514,000, which was annulled by the Commissioners on Jan. 16, 1900. The annulment was precipitated by a recent communication from the Commissioners requesting complete detail working plans and specifications. In response to this the contractors sent a communication which closed as follows:

> The time which has been consumed in meeting your requirements for changes and in awaiting your efforts to obtain judicial sanction of such public lettings of contracts as the one made in this instance, the inhibition of your contract which forbade us to obtain materials with which to meet your ultimate requirements whenever they might be determined upon; the extraordinary increase in prices of materials and labor which has intervened, and the unreasonable demand you now make upon us, not to speak of other reasons, justify and compel us to rescind the contract, and we hereby do rescind it, and this company hereby notifies you that it will hold you responsible for the losses and damages it has suffered by reason of the premises.

MORE ARTESIAN WELLS FOR MEMPHIS, TENN., are being sunk by the Artesian Water Co. There will be 20 new 10-in. wells, having an average depth of 500 ft.; also 1,400 ft. of 5-ft. brick-lined tunnel and 3,000 ft. of 36 x 42-in. drifts. The tunnel and drifts are 90 ft. deep, and two 10-ft. shafts, 95 ft. deep, are being used to carry on the work. The estimated cost of the improvement is $105,000. The engineer is Mr. Thos. T. Johnston, of Chicago. Mr. W. B. Johnson is Superintendent of Construction.

STREAM POLLUTION AT BIRMINGHAM, ALA., is before the chancery court, Mr. James L. Sandifer having applied for an injunction to prevent the discharge by the city of sewage into Valley Creek. The bill alleges that the complainant, a lower riparian owner, is damaged, in common with the public, by foul and unwholesome odors from the sewer; that his lands are flooded by sewage, and that the water of the creek is rendered unfit for use by man and beast. The city filed a demurrer to the bill, all of which was disallowed, except that portion holding that no action can be brought to prevent the discharge of surface water into the creek. With this feature of the bill stricken out the case will go to trial.

THE WATER POWER PLANT AT MOLINE, ILL., on the Mississippi River, now supplies electric current to Moline, Davenport and Rock Island, and when completed it will furnish power for the large factories, as well as for lighting and street railways. The works of the Moline Plow Co. were formerly run from water wheels, but the power was destroyed when the main channel was deepened, and a steam plant was put in. Now the old tail race is being filled up to form a site for new buildings, and the plant will be run by electricity furnished from the new water power station of the Moline Power Co. There are already 12 wheels, of 150-HP. each, and there is provision for 30 wheels. The machinery of the U. S. Arsenal on Rock Island will also be driven by electric current, generated by a separate water power plant. The present government water power plant drives a rope transmission system.

THE BARREN ISLAND GARBAGE REDUCTION WORKS, GREATER NEW YORK.

(With two-page plate.)

It is not generally known that the bulk of the garbage of Greater New York is converted into marketable grease and a fertilizer base by the largest garbage disposal works in the world. This plant has a contract capacity of 1,000 tons a day, and it is claimed that as high as 1,500 tons a day have been treated by it for short intervals during the height of the season. The plant is located at Barren Island, in the Rockaway Inlet to Jamaica Bay, remote from centers of population, yet within the limits of New York city (see Fig. 12). The works are practically in duplicate, although now operated as one huge enterprise. This is due to the fact that each of the two great factories was built to fulfil a separate contract, the first made with New York and the second with Brooklyn, prior to their consolidation into Greater New York. The same process is used in both factories, the joint works being operated by the New York Sanitary Utilization Co.

The first contract was executed on June 6, 1896, between the city of New York and the New York Sanitary Utilization Co. It runs five years from Aug. 1, 1896, and is based on an estimated quantity of 500 tons of garbage a day for 313 days in the year. The contract price was $89,990 a year, including the furnishing of scows by the contractor, the reception of the garbage thereon, its transportation to the reduction works and its final disposal in an unobjectionable manner. The contractor is obliged to receive the garbage at dumping places provided by the city on its water front as it then existed, not exceeding 18, unless otherwise agreed. Garbage was defined as meaning

the refuse of an organic nature, not including "street sweepings," collected by the carts of the city or by duly authorized private carts and delivered at the dumps or other places of final disposition, and containing not more than 10% by weight of other refuse.

The second contract was made on Nov. 16, 1896, by the then city of Brooklyn and the Brooklyn Sanitary Co., Mr. F. L. Cranford, President. It covers five years, from Jan. 1, 1897, and provided that until May 1, 1897, the plant of the New York company might be used. The contract price for the five years aggregated $605,000, or an average of $121,000 a year, divided by years as follows:

First	$113,000	Fourth	$125,000
Second	117,000	Fifth	130,000
Third	120,000	Average	$121,000

This contract, it should be noted, includes the collection, transportation and final disposal of the garbage of Brooklyn, instead of the last two, only, as in the New York contract. The basis of the bid was $1.25 per ton collected for about 250 tons a day, 365 days in the year, for the first year, with some allowance for subsequent increase. The contract called for a plant with a maximum capacity of 500 tons a day.

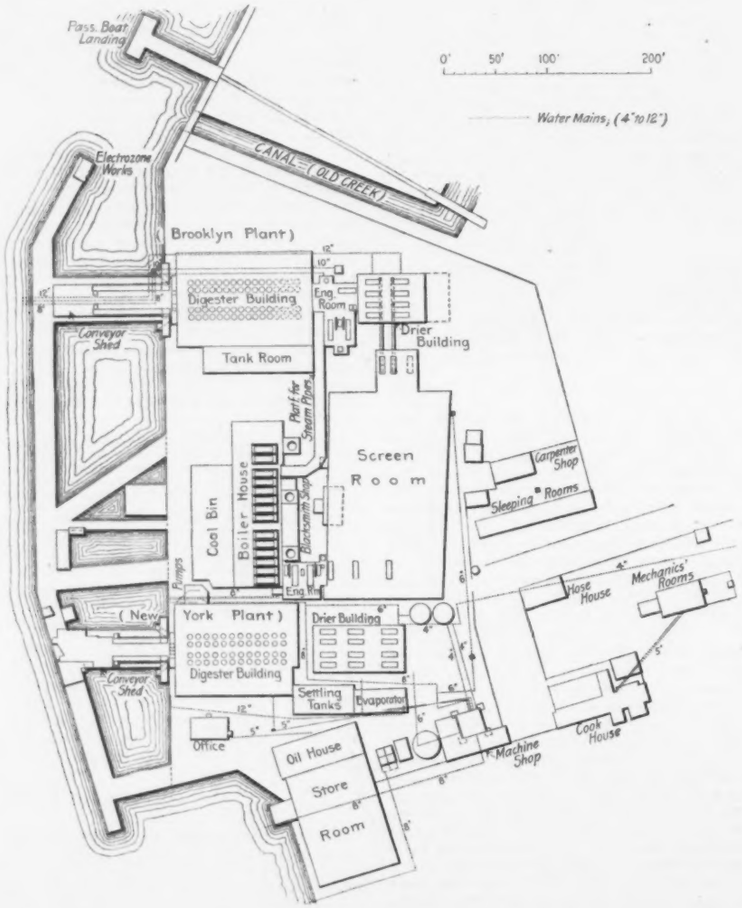


FIG. 1.—GENERAL PLAN OF BARREN ISLAND GARBAGE REDUCTION WORKS, GREATER NEW YORK.
Charles Edgerton, M. E., Engineer.

Before proceeding to describe the combined plants in detail a few words may be said regarding the disposition of garbage in parts of Greater New York not covered by these two contracts. First, it may be noted that a portion of the old town of Gravesend, well known throughout the country as Coney Island, began to burn its garbage in an Eagle furnace as far back as 1889. The use of this furnace was discontinued about 1896. On July 1, 1895, a Brownlee furnace was put in operation by the then village of New Brighton, Staten Island, now a part of the borough of Richmond. This has been in use most of the time since that date, but was discontinued about Nov. 1, 1899, with the completion of the plant for the whole borough of Richmond, mentioned further on. About the middle of 1896 a furnace designed by Burns was erected by Norton & Gorman, for the former towns of Flatbush, New Utrecht and Gravesend, which had recently been annexed to Brooklyn. The amount of garbage from this section, in the summer, proved to be far beyond the anticipations of the contractors, and the furnace was altogether too small to handle it. The furnace was continued in use for a year or so, but was finally abandoned, either on account of the high cost of operation or because of the expiration of the contract.

In March, 1899, bids were received by the Department of Street Cleaning for the reception and final disposition of street sweepings, ashes and garbage in Queens and Richmond boroughs during the balance of 1899 and the whole of 1900. The contract was awarded to Mr. Zephaniah F. Magill, of Troy, N. Y. He agreed to build furnaces of the Brown type, but later secured an amendment to the contract permitting the use of Dixon furnaces. Five of the latter were completed during the last part of 1899, located, respectively, at Long Island City, Flushing, Jamaica, Far Rockaway and West New Brighton. The first four serve Queens and the last one Richmond borough.

The bulk of the ashes, street sweepings and light refuse of Greater New York is now towed out to sea and dumped. The percentage so disposed of varies with the opportunities afforded for depositing on land. In 1899 some 60% of the total went to sea, but in 1895 about 90% was towed and dumped. The length of tow is about 25 miles from the Battery for eight months, and 20 miles for four months in the year. Since 1895 a portion of the dry, light refuse of the city (Manhattan borough), including rags, paper, pasteboard, excelsior, barrels and boxes, and also a miscellaneous collection of junk, has been gathered separately and hauled to a refuse-sorting and burning plant. The first of these was described in our issue of Nov. 21, 1895. Rags, paper and other material of value were picked from an inclined conveyor by men and boys, and the balance went to a Colwell furnace. The heat generated was more than sufficient to operate the plant. This first plant was shut down in 1896, but in May, 1897, a similar plant, also having a Colwell furnace, was put in use on East 18th St. This plant is still in operation, although changes have been made in the furnace. The development of the refuse-sorting idea was carried out quite largely by Mr. Herbert Tate, in conjunction with the late Col. Waring.

It hardly seems necessary to say that the final investigations resulting in the adoption of the reduction process for the treatment of the garbage of New York were made by Col. Waring and an able corps of assistants, several of the latter still being in the employ of the Street Cleaning Department. Brooklyn profited by this work, although subsequent to the publication of Col. Waring's "Report on the Final Disposition of the Wastes of New York" the Health Department of Brooklyn made an independent investigation and report on the same subject, as related to Brooklyn. As is set forth more particularly in our editorial columns, investigations in New York previous to those of Col. Waring had resulted in the recommendation of the reduction process, so, altogether, it is apparent to any one who gives the matter proper attention that neither New York nor Brooklyn rushed blindly into the contracts under which the Barren Island reduction works were built and are being operated.

The Arnold system of garbage reduction, controlled by the American Sanitary Product Co., of Philadelphia, is employed.

The New York plant was put in partial operation in December, 1896, and began to receive garbage from Brooklyn in 1897. The Brooklyn plant was put in use later on in 1897, or early in 1898, at which time the original factory was in need of heavy repairs on account of the unexpected amount of work thrust on it by the two cities.

The garbage is dumped from the carts onto deck scows, five dumps and an average of 14 scows being used under the New York contract and one dump and six scows under the Brooklyn contract. The scows carry an average of 300 tons of garbage, and one tug usually tows two scows. Barren Island is about 25 miles from the

Battery by the scow route, and the average length of towage is about 27 miles for the New York and about 18 miles for the Brooklyn contract.

The two garbage reduction plants are very similar in design, but the Brooklyn factory having been built last has some improvements not originally found in the other, although many of them are being introduced as opportunity arises. The line illustrations on the inset sheet are reproduced from the designs for the new or Brooklyn

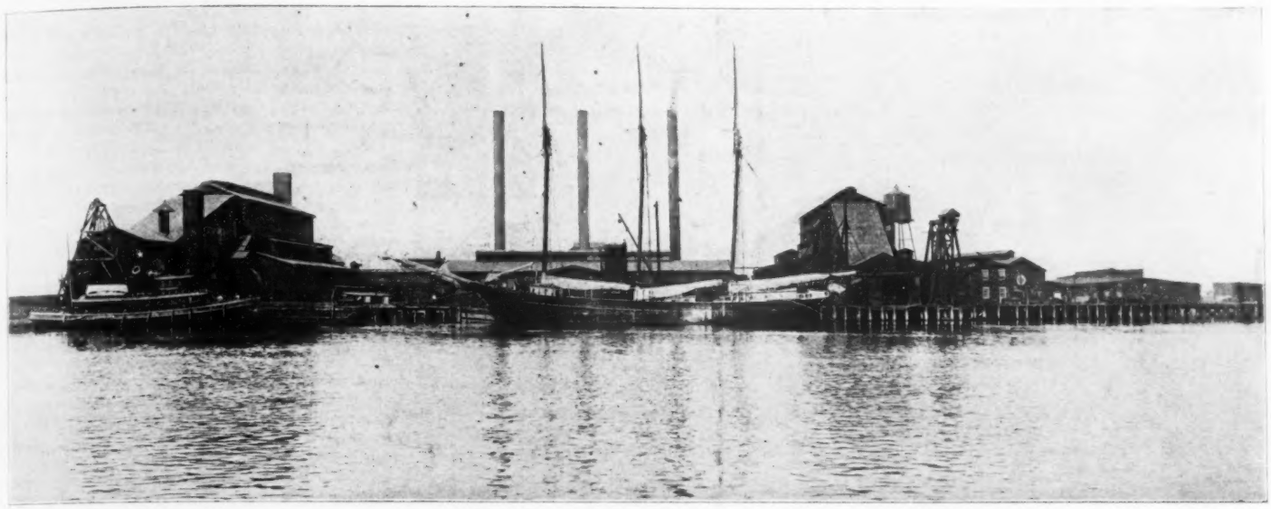


FIG. 2.—GENERAL VIEW OF BARREN ISLAND REDUCTION WORKS.

plant. The notes at the works were taken in the old or New York factory, but they have been supplemented from other sources and in a general way, and in most details, relate equally to both plants.

A general plan of the whole works at Barren Island is shown by Fig. 1, and a fair idea of the exterior, from the water, is shown by the large views, Figs. 2 and 3. These views are misleading in that the derricks there shown in place for unloading the garbage are not now in use, having been replaced by short conveyors. The details of the process and plant are given further on, but will be understood better if outlined here, with further references to the illustrations. The green garbage at each factory is taken to the digesters by two main conveyors, shown in Figs. 4 and 5, on the inset sheet, is cooked by steam in 48 digesters, pressed in twelve screw presses, dried in twelve driers, screened by three screens and finally bagged. The grease and water discharged from the presses is separated, the grease barreled and the water evaporated to "stick," the latter being mixed with some of the dried tankage.

The process may now be taken up in detail at one of the factories. A short line of conveyor extends from the dock onto the scow and from 10 to 13 men with forks or shovels throw the garbage into it. This conveyor empties into a cross-conveyor, running at right angles to the first, and discharging at will into either one of the two main conveyors leading into the digester house.

So far as is practicable tin cans and similar rubbish are picked off the conveyor before the garbage goes to the digesters. The solder is melted from the cans, and the tins, while hot, are placed in a form and compacted by a little trip hammer into bales weighing about 85 lbs. per cu. ft. These are shipped away for melting into window weights, etc.

The scows can be moved along by means of an engine, so it is not necessary for the shovellers to carry the garbage from remote points of the scow to the short conveyor. The conveyors for green garbage are moved by an independent engine. Originally, the garbage was thrown from the scows by hand into coal buckets, which were swung around on the dock, the latch slipped and the contents dumped into a hopper so arranged that the garbage could be dumped by it into either one of the main conveyors.

The conveyors for green garbage (see Figs. 4 and 5, on the inset sheet) are continuous steel troughs, with blades, or flights, at right angles, some 2 ft. c. to c., carried forward by sprocket chains, to which the blades are attached. Over the digesters, at proper intervals, sliding doors, operated by rack and pinion, are placed in the bottom of the conveyors. Beneath each door is a funnel and a feed pipe, Fig. 8, with a swivel joint, so any one of four digesters may be fed through it.

There are 48 10-ton digesters in each digester house, placed in two pairs of rows of twelve per row. Unless crowded, not over eight tons are placed in one digester. Each digester is a vertical steel cylinder, $5\frac{1}{2} \times 14$ ft., not including the dome-shaped top and conical-shaped bottom, the latter being about $2\frac{1}{2}$ ft. deep. The cylinders, laterally, are composed of $\frac{5}{8}$-in. steel plates, lap-jointed, with double-riveted vertical and single-riveted horizontal joints, the rivets being $\frac{7}{8}$-in. in diameter. The heavier tanks replaced lighter ones, composed of $\frac{1}{2}$-in. plates. The dome-shaped tops of the digesters are also made of steel plates, having openings for charging the digesters. The doors or covers are of cast iron, hinged to a frame. A circular ring of lead pipe is used for a gasket between the door and frame, the door being fastened by means of swing or hinged bolts, as shown in the view, Fig. 8. A horizontal gate valve, shown in Fig. 9, controls the discharge end of the digester.

Before a digester is charged with garbage, water is admitted to a depth of 3 or 4 ft. When charged, the charging door is locked and the garbage is

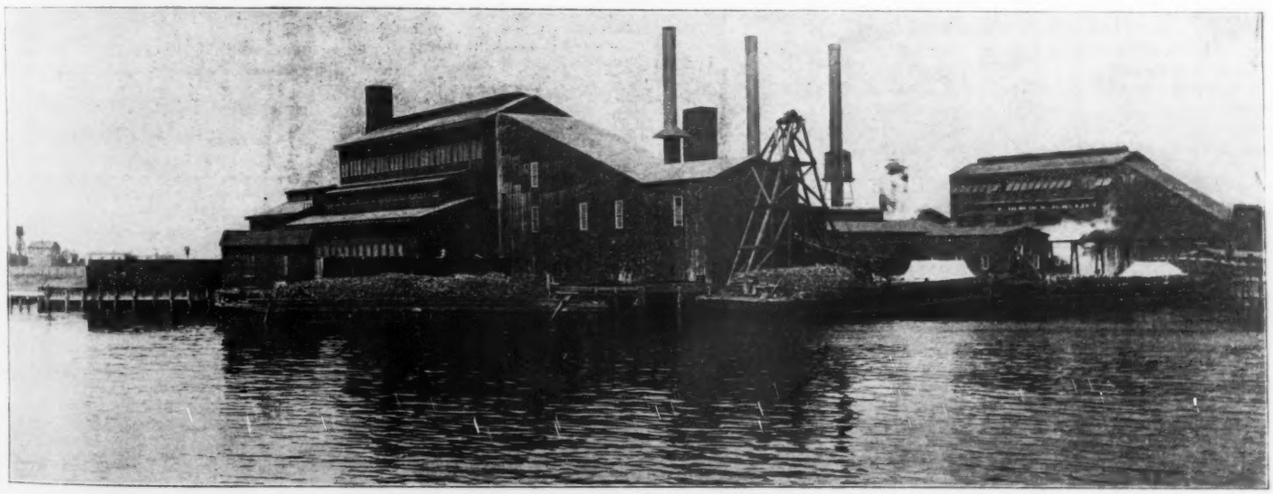


FIG. 3.—END VIEW OF BARREN ISLAND REDUCTION WORKS.

cooked about eight hours, under a pressure said to range from 30 to 80 lbs., the temperature increasing as the cooking progresses. The boiler pressure is from 90 to 100 lbs.

The digesters are connected, in sets of four, with receiving tanks (see Fig. 9), also made from steel

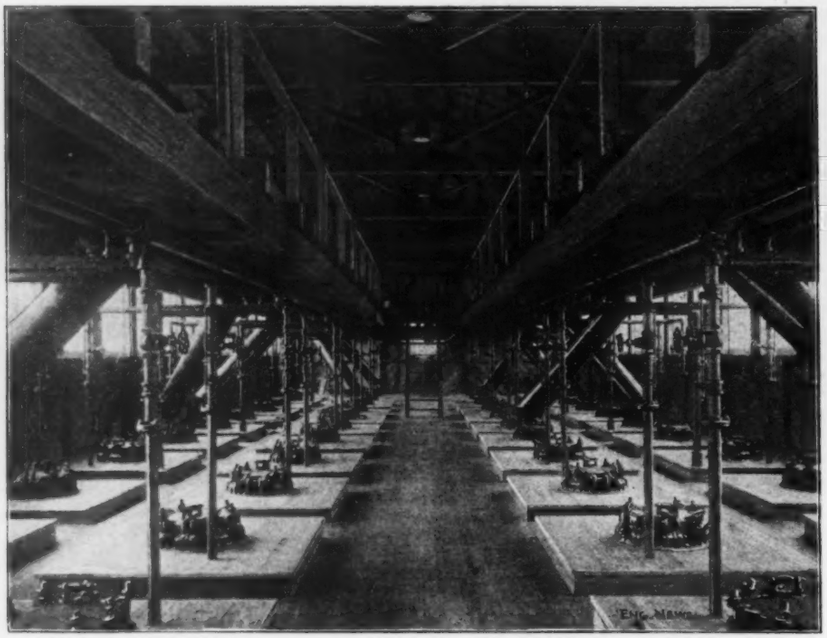


FIG. 8.—CHARGING DOORS OF DIGESTERS, SHOWING FEED PIPES FROM CONVEYORS AND PIPE SYSTEM.

plates, each tank being 14¼ ft. long, 12½ ft. wide and 7 ft. high and having a bottom sloping each way to the center. Here an opening is provided for discharging the cooked garbage onto cars, where it is built up by the aid of wooden racks and gunny-sacks into forms or cheeses and run beneath the presses. A telescopic pipe, adjustable to the height of the form, is used to convey the garbage from the receiving tank onto the racks. By having four digesters connected with one receiving tank the track system and the press-filling operation are simplified and it is only necessary to have one discharge opening to the outer air for each four tanks.

The racks are about 5 ft. sq., made up of wood slats. The gunny-sack is turned up around the edges of the wet garbage and secured by wire pins to prevent squeezing out the garbage at the sides.

There are 16 presses (Fig. 10), eight on each side of the digester house, made by the Boomer & Boschert Press Co., of Syracuse, N. Y. They are of the four-screw, three-speed type, and are operated at a pressure of about 100 lbs. per sq. in. on the press head, or platen. The pressing is started with the screws working at a high speed, continued at mid-speed, and finished at the slow speed. When the process is completed the cars are run to the end of the building, the tankage emptied from the racks and sacking into a flight conveyor and lifted to and dumped on the second floor. From this floor the pressed tankage is shovelled into the driers.

There are twelve driers, made by Theo. Smith, of Jersey City. The driers, shown by Fig. 11, are steel cylinders, about 5 ft. in outside diameter and 14 ft. long, placed horizontally and carrying a charge of two or three tons. They are jacketed with live steam under say 75 lbs. pressure. A central shaft, provided with blades, is rotated to keep the tankage stirred up while drying. The dried tankage is now discharged from one end of the driers into cross-conveyors leading to the screens. An Anderson drier and mixer is used for the part of the tankage to which the "stick" is added. This product is of a higher grade than the ordinary tankage.

The tankage and screen house contains three rotary screens and ample room for storage. The tailings from the screens, after having bones picked out, are used for filling purposes.

The screened tankage is bagged and sold to manufacturers of fertilizers.

Having followed the solid portion of the garbage through the whole process of treatment the liquids may next be considered. A drainage system is provided beneath the press-room floor, which collects the water and grease from the presses. The hot water and grease go to a series of grease traps, or tanks provided with partitions extending only part way to the bottom. The grease and water separate by cooling and the grease is pumped to settling and storage tanks, to be barreled for shipment. The water is pumped to filtering tanks, where more grease is removed by skimming, and finally goes to the evaporators, of which there are three. A modified form of triple effect sugar evaporator is used, the vacuum increasing as the evaporation progresses. A vacuum pump and a centrifugal pump is placed beneath each drier, the latter serving to lift the liquid from one drier to the next. The final product, or "stick," is mixed with some of the tankage, as already described.

There remain for consideration the provisions made to prevent nuisances incidental to the concentration, handling and treatment of such immense quantities of garbage. The only thing of the kind possible while the garbage is being unloaded from the scows and conveyed into the buildings is the use of deodorants, of which a variety have been tried. A plant for producing hypochlorite of sodium from sea water by means of electrolysis, under the trade name of "electrozone," has been installed. Deodorants are not necessary during cold weather. In the summer they are sometimes applied at the city dumps, by the Street Cleaning Department, Smith's carbolic powder having been used recently for that purpose. The scows are washed down after each trip with hot water and sprinkled with chloride of lime.

The free steam and gases in the digester and press house are exhausted by an immense Sturtevant fan, some 20 ft. in diameter, and 6 ft. face, and passed through a large scrubber, as shown by Figs. 6 and 7 on the inset sheet. This scrubber is a recent installation, designed to prevent all cause for complaints regarding the escape from the building of offensive odors due to the open handling of green and cooked garbage. A large centrifugal pump, with a rated capacity of 3,500 gallons a minute, supplies water to the scrubber through perforated brass pipes extending across its top, as shown in Fig. 7. A series of paddle-wheels below keeps throwing the water upwards, after it has fallen, and the baffle boards do their part towards keeping the interior of the scrubber filled with sprays of water. The vapors and gases exhausted from the building are supposed to be largely condensed in traversing the length of the scrubber. Anything remaining goes up the tower at the discharge end, where further scrubbing takes place.

The gases from the digesters, driers and evaporators are passed through spiral jet condensers.

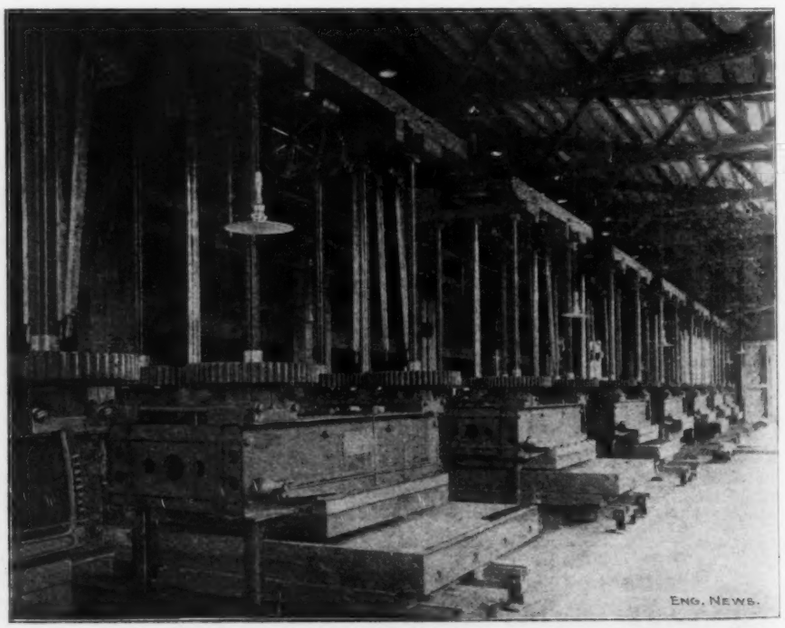


FIG. 10—FOUR-SCREW PRESSES FOR REMOVING GREASE AND WATER FROM COOKED GARBAGE.

There are three condensers connected with the driers, and one each with the digesters and evaporators. In the condensers the gases and a jet of cool water fall together in a closed pipe about 30 ft. long, a tank at the bottom receiving the original water and condensed vapors. Uncon-

densed gases were formerly passed under the rear end of the boilers, but they are now discharged under water. Professor Landreth stated in his report, dated June 30, 1898, that the digester condensers usually work under a vacuum of about 15 ins. of mercury, but that the drier condensers showed only ½-in. He stated further:

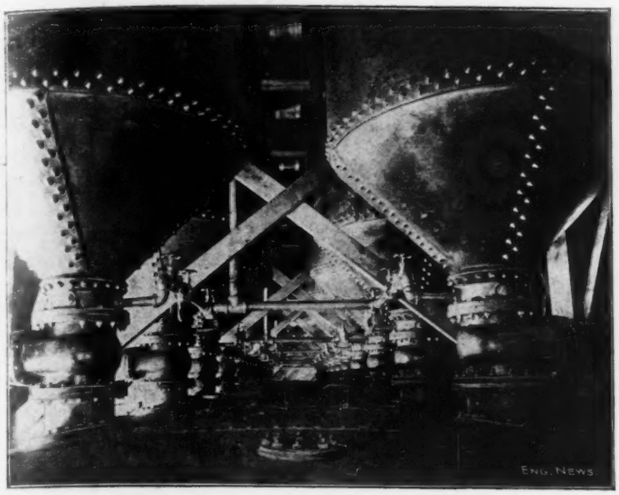


FIG. 9.—BASE OF DIGESTERS AND TOP OF RECEIVING TANKS FOR COOKED GARBAGE.

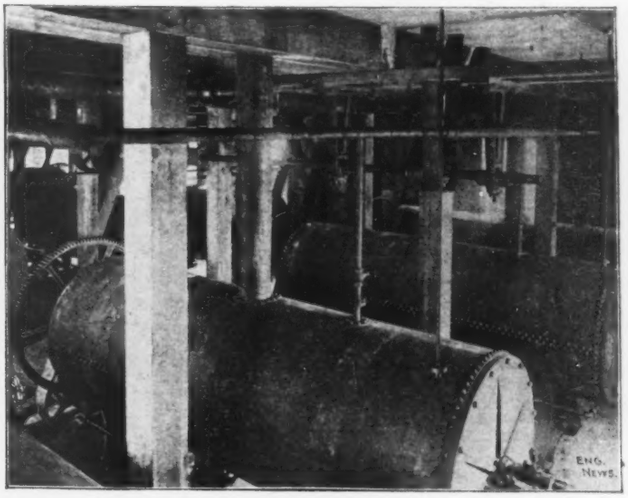


FIG. 11.—DRIERS FOR THE FURTHER REMOVAL OF MOISTURE FROM TANKAGE.

In the condensers connected with the evaporators and with the driers, no uncondensed gas remains, at least no odor was detected and no provision is made for piping it away. The temperatures of the air, water used for cooling and final temperature (° F.) of water after condensation as I found them on the 29th inst., are as follows:

	Air.	Sea (or condensing) water.	Driers.	Water in condensers on digesters.
Original	75	68	80	110
Increase	..	..	12	42

Professor Landreth called attention to the fact that the uncondensed gases passing to the chimney base had a temperature of 110° F., "while the chimney gases have a probable temperature of about 600° F.," from which he concluded that "no combustion of this gas is at all probable." This has been recognized by the company and the gases are now discharged under water, as reported above.

Twelve Coatesville boilers, of about 250 HP. each, were provided for the original plant and five have been put in since for the Brooklyn addition. Four 150-HP. horizontal Corliss engines furnish power to both the old and new plants, besides which there are employed for various purposes one 100 and two 50-HP. upright engines. Two air compressors are provided for the air-lift pumps and there are three dynamos for lighting purposes. There are several pumps connected with the works, supplying water for the boilers, condensers and scrubbers and lifting the water and grease that comes from the presses. The water supply for the boilers and digesters is from two 6-in. wells, 857 and 914 ft. deep, respectively, and is raised by air lifts. Salt water is used for the condensers and scrubbers, a 20-in. main leading from the pumps with branches of smaller pipe to each factory.

Tons of Garbage Collected in New York City, 1897 to 1899, Inclusive.

Month.	Old New York,	Manhattan and Bronx.		Manhattan, Bronx and Brooklyn. Brooklyn,	Total,
	1897.	1898.	1899.	1899.	1899.
January	10,120	9,050	9,460	7,800	17,260
February	8,410	8,720	6,730	8,050	14,780
March	10,660	10,640	8,400	8,500	16,940
April	11,770	10,660	8,930	8,740	17,670
May	14,490	12,200	13,500	9,100	22,600
June	16,420	12,800	14,330	9,200	23,530
July	16,630	13,110	15,570	10,230	25,800
August	15,550	15,750	18,300	10,940	29,240
September	15,640	14,950	16,320	11,500	27,820
October	14,360	13,680	16,100	8,240	24,340
November	12,910	11,000	12,700	6,300	19,000
December	11,540	9,750	11,220	5,400	16,620
Total	158,500	142,400	151,600	104,000	255,600

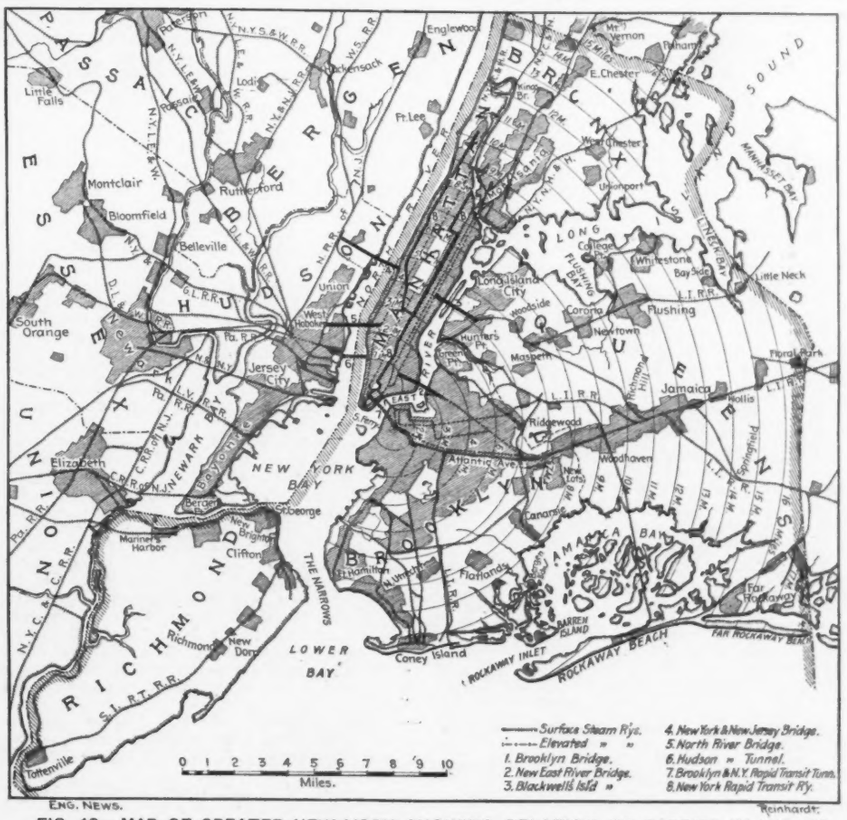


FIG. 12.—MAP OF GREATER NEW YORK, SHOWING RELATION OF BARREN ISLAND TO CENTERS OF POPULATION.

The new or Brooklyn plant is practically a duplicate of the old or New York plant. It is proposed to add 16 digesters to the Brooklyn plant, making 64 there (as shown on the inset sheet) and 112 in all, and giving a total daily capacity of about 1,200 tons of green garbage. With the present 96 digesters the managers of the plant state that as high as 1,500 tons have been treated in one day, by crowding, but this gives time for only partial cooking and no leeway for repairs or other emergencies.

The reduction works were visited on Jan. 8, 1900, by a member of the editorial staff of this journal, in company with Messrs. Chas. A. Meade, Superintendent, and Macdonough Craven, Inspector of Final Disposition of the Department of Street Cleaning, and Thos. F. White, 41 Peck Slip, New York, of the New York Sanitary Utilization Co. Besides these gentlemen we are indebted to the following for courtesies and information: Jas. McCartney, Commissioner, and F. M. Gibson, Deputy Commissioner, of the Department of Street Cleaning; Chas. Edgerton, M. E., of Philadelphia, Chief Engineer, and W. W. Gooch, 15 Wall St., Attorney for the contractors.

The amounts of garbage treated at Barren Island by months since the works were started is shown by the accompanying table:

No satisfactory figures are available for the borough of Brooklyn prior to 1899. In 1897 about 10,000 tons of garbage from the city of New York, as it then existed, were sent to sea, divided about

equally between the first four months of the year. In 1898 only 35 tons of garbage from the boroughs of Manhattan and Bronx were taken to sea, and in 1899 there were 1,300 tons gotten rid of in that manner. These figures, as well as those in the table, were prepared especially for us by Mr. Meade, who states that except for the 11,335 tons sent to sea the 556,500 tons total given in the table were treated at the Barren Island reduction works. Estimating at about 160,000 tons the amount sent from Brooklyn to Barren Island during the two years 1897-8, the total amount reduced since the plant was put in operation would be 700,000 tons. The total amount collected in 1899 averaged 484 tons a day for Manhattan and the Bronx and 332 from Brooklyn, or 816 tons in all. It will be noticed that the amount collected in Manhattan and the Bronx in 1898 was 10% less than in 1897, and about 5% less in 1899 than in 1897. As the population has doubtless increased, either the garbage had more ashes and other refuse mixed with it in 1897 than since, or more of the garbage has been put in ash cans during the past two years than formerly. The report of the Street Cleaning Department for 1898 attributed the diminution in garbage for that year to mixing it with ashes.

LEGAL DECISIONS OF INTEREST TO ENGINEERS.

(Reported for Engineering News by Andrews & Murdoch, Berrien Springs, Mich.)

Grant of Rights in Highway—Rights of Abutting Owner.

A town is not liable for damages sustained by an owner of land because of the lowering of a highway in front of his land by a street railway acting under a franchise lawfully granted it by the selectmen of the town.

Purinton vs. Inhabitants of Town of Somerset, 55 N. E. Rep. (Mass.) 461.

Governmental Functions.

An administratrix cannot maintain an action against a city to recover for the death of her interstate, caused by the city's neglect to observe sanitary principles in the construction of one of its sewers, by reason whereof the cellar of the house where plaintiff lives was, in time of heavy rains, filled with sewage, which generated unhealthy vapors and odors, causing the illness of which plaintiff died.

Hughes vs. City of Auburn, 55 N. E. Rep. (N. Y.) 389.

Railroads—Removing Grade Crossing.

Where a railroad company, to remove a grade crossing, closes a street on which a lot abutted, at a point not in front thereof, and without interfering with the easement of access immediately in front thereof, the owner cannot maintain a private action for damages, though access to it is rendered more inconvenient—a more circuitous route being necessitated—since the injury sustained is one in common with the public.

Newton vs. New York, N. H. & H. R. R. Co., 44 At. Rep. (Conn.) 813.

Electric Lighting—Easement in Streets.

A city having only such power to grant an easement in a street as is given by the legislature, and there being no authority in its charter for granting perpetual easements, and the records of the common council showing only the right to place poles and wires in the street was granted complainants, who have no franchise from the state, in connection with a proposition to do city lighting, a contract for which for a limited period was afterwards given them, and lamps for lighting the streets being put in before any were used for private lighting, and the only private lighting being that of a few buildings along the streets used for city lighting, they have no right to continue their poles and wires in the streets, after the city has ordered them out, at termination of contract.

Horner et al. vs. City of Eaton Rapids, 80 N. W. Rep. (Mich.) 1,012.

Selection of Route.

Vol. 14 Del. Laws, c. 513, authorized a railway company to survey, locate and purchase any lands within a certain district necessary for a right of way between given termini, and authorized the appointment of commissioners to assess the damages of landowners on such route, and provided the company, on paying such damages, or depositing the award to the credit of the landowners, should be entitled to the lands for which they were given. The railway company, after numerous surveys, selected a route along which they proposed to construct a line, provided the damages assessed were not more than they could afford to pay; and at their request commissioners were appointed, who, on inquisition, assessed damages which the company declared they were unable to pay, and thereafter the company selected another route, which passed over plaintiff's land, and other commissioners assessed damages therefor, which plaintiff refused to accept. Held, that since the first selection and assessment of damages did not vest any right or fix any liability on the company, it did not exhaust its power to "locate" another route, and hence the second selection was valid.

Williams vs. Odessa & M. Ry. Co., 44 At. Rep. (Del.) 821.

COVERED RESERVOIRS.*

By W. S. Shields.†

The following is a brief description of two small covered storage reservoirs erected in 1898 at Attica, Ind., and Delphi, Ind. The city of Attica, Ind., has some 3,500 inhabitants, and is located on the Wabash River below Lafayette. The city is located on a hillside, with a difference of elevation of 120 ft. The water supply is obtained from five 6-in. wells, located along the edge of the water in the river. These wells are all connected below the water line with a 14-in. main, having a 16-in. suction main to the pumps, which consist of two 9 × 12 × 8½ × 15 compound condensing vertical Worthington engines. A 12-in. main passes from the pumps through the center of the city to the reservoir, 200 ft. above the pumps.

The reservoir is located on a knoll of sand and gravel, and is half in excavation and half in embankment. It is 75 ft. in diameter, and has an average depth of 15¼ ft. below the overflow line. The masonry wall is built of Posten paving blocks (seconds), costing $8 per 1,000 f. o. b. Attica, one mile from the site. They are laid in Portland cement mortar, Buckeye Portland cement being used for the greater part. The blocks are 9 × 3⅜ × 3⅜ ins., and all work was slushed in place. The wall, when completed, had a thickness of about 19 ins. The bottom was placed on fine, sharp sand, and consisted of 12 ins. of clay puddle well tamped in place, extending beneath the walls and outer puddle wall; and on top of this was placed 6 ins. of concrete; all having a slope of 6 ins. towards the center. On top of this concrete was spread a ¼-in. coat of hot asphalt, covering the bottom and up the sides for a few inches.

The 12-in. feed and discharge pipe entered just through the outer wall, and terminated with an increaser to 16 ins. The 14-in. drain and overflow pipe enters through the same trench and passes to the center of the reservoir, where there is a tee with a vertical branch extending to the overflow line of the reservoir. On the end of the main drain is placed a single gate valve, with stem carried above flow line and supplied with a wheel. Around this vertical pipe is built a brick pier, 3 ft. square, with four openings at the flow line to give entrance to the vertical pipe, which is here increased to 16 ins. diameter. Iron ladder rounds are built into this pier for entrance, and the valve rod of the drain pipe is supported at intervals, and the pier is carried up and helps support the roof.

Around the outside of the wall is placed 3 ft. of clay puddle, placed in layers and well consolidated. Then outside of this the earth embankment is placed, both being carried to within 2 ft. of the top of the wall, giving a top width of 8 ft. and a slope of 1 on 2. The roof consists of five 10-in. I-beams, supported on 14 5-in. cast-iron columns and the center pier. The beams are so set as to give slopes of 2 ft. in two directions from the center; and crossing these at right angles are placed T-irons, 3½ × 4 ins., clamped to the beams and spaced 25 ins. c. to c. When the iron work was put in place, the wall was built around the ends of beams and T-irons, and then brick arches were built between the latter. These arches were laid in cement, and when completed the whole was plastered over and made smooth and uniform. Over the center was left an opening 8 ft. square, around which was erected a substantial frame house with ventilators and door for entrance.

One of the conditions in the contract was that the walls should be water tight; and the walls were considered so well built that the contractors decided to let the water in without plastering the walls, as required. This was done, and the reservoir filled to flow line and then closed off. The leakage through the masonry was found to be 19 ins. in depth for the first 24 hours, and 17 ins. for the second. It was allowed to stand for one week and again filled, when the leakage for the first 24 hours was 12 ins. The water was drawn off, except 3 or 4 ft. in the bottom, and was allowed to stand several days with no perceptible loss, showing the leakage to be through the walls. The inner surface of the walls was given a thorough wash of soap and alum, after which the reservoir was again filled and tested. This time a loss of but 7 ins. per day was found. The weather being too cold to do further work, the reservoir was used for four months, when a test showed a loss of 5 ins. per 24 hours. It was then treated with a coat of plaster, composed of 1 part Portland cement, and 2 parts fine screened sand, and allowed to stand for four days, when it was again filled; and after standing for 72 hours, no loss was found to have occurred, and the work was accepted.

The contract price for this work, including land, right of way, engineering, and inspection charges, was $5,000. The contractors were J. A. Foster and H. C. Martin, both of Attica, Ind.

The city of Delphi, Ind., is also situated on the banks of the Wabash River, and has a population of some 2,500 to 3,000 people. The water supply is obtained from springs located about three miles up a small stream, the water being conveyed this distance through a line of 6-in. Wyckoff wood pipe. The total fall between the springs and the floor of the pumping station is 58 ft. A weir, placed so that the flow could be measured, showed that with a head of 61 ft., this 6-in. line, 15,840 ft. in length, delivered approximately 164 gallons of water per minute. In the original plant, two pumps of 250,000 gallons capacity were attached to the end of this pipe, and a by-pass provided, through which the water might flow by gravity into the low pressure reservoir, thence through the distribution system to the consumers. This arrangement proved very unsatisfactory, as the gravity pressure was not sufficient to deliver water to the second stories of many of the residences; and even when the pumps were being operated, there was not sufficient water for sprinkling purposes.

In the fall of 1898, a reservoir with a capacity of 300,000 gallons was constructed at the pumping station, and the pipe line allowed to discharge into this reservoir, with a 12-in. suction pipe connecting with the old pumps, and with a new pump of 1,000,000 gallons capacity, which was added to the plant. After the reservoir was completed, it was found that the pipe line delivered from 180 to 190 gallons of water per minute into the reservoir.

The reservoir was placed in rock excavation, which was very difficult to excavate, being full of flint, broken in layers and found to be full of seams of water. A previous attempt to secure an additional supply of water by sinking an artesian well had resulted in striking a small vein of oil and gas, which created an offensive odor, ate away the iron tubing of the well and allowed this water to percolate through the rock in the vicinity, making it very essential that all outside water should be excluded from the reservoir. This reservoir was 60⅝ ft. in diameter, and 15 ft. in depth, with a flow line at a height which gave slightly over 300,000 gallons storage capacity. The walls are composed of brick masonry built into the natural rock excavation, and have an average thickness of 16 ins. The brick are laid in Utica cement mortar and slushed in place, filling all interstices in the rock with masonry. Where streams of water were encountered, pipes were laid through the wall, draining the leaks, until the cement had set, when they were capped.

It was found on the side next to the abandoned well that the water forced its way through the brick masonry, so that section of the wall was taken out and two 8-in. walls were built, with a narrow space between, which was filled with hot asphalt. These walls were laid in Portland cement, and when completed no indications of leaks could be found.

Owing to the bad rock in the bottom of the reservoir, much trouble was found in getting a tight bottom. The inequalities in the bottom were first covered with neat Utica cement, and on top of this was placed concrete sufficient to level the inequalities and form a slope to a point beneath the suction pipe, where a sump pit, excavated some 3 or 4 ft. below the rest of the reservoir, was constructed. A steam siphon was kept constantly in operation, keeping the water pumped from the pit, which drained the bottom of the remainder of the reservoir and kept the water down until the concrete had set. It was found necessary to put an average of nearly 18 ins. of concrete over the bottom to prevent the water from breaking through. After the required amount of 9 ins. had been placed upon the bottom, when leveled and brought to a sub-grade, it was found that when the water was allowed to rise in the sump pit it would ooze up through the concrete in many places; none of which were larger than the point of a pencil. The most effective way found to stop these leaks was to enlarge the opening in the concrete to an inch or so in diameter, and several inches deep. Into this opening was rammed tough blue clay, which held the water back until the cement had set. It was found that leaks could be stopped in this way when they could not be stopped by the use of Portland cement alone.

Several attempts were made to utilize asphalt in the wall, but, owing to the dampness seeping through the wall from the outside, the asphalt would not adhere to the surface of the brick. Even with brick which had been dried and dipped into the hot asphalt and laid in Portland cement, after standing in the wall for several days, the face coating of asphalt would blister and become loosened from the brick. The only effective way in which the asphalt was used was by placing it between two walls as above described. The inner surface of the walls was plastered with Portland cement, and the covering put in place. This consisted of steel I-beams, 8 ft. c. to c., and supported on cast-iron columns, all well tied with 1-in. tie rods, and carrying brick arches consisting of a single row of selected brick. The brick were laid dry and thoroughly keyed with slate. Then over the entire surface was poured a thin grouting of Portland cement mortar. Over this was placed sufficient concrete to fill all the depressions between the arches, and to give a total thickness at the crown of the arch of 9 or 10 ins. After the masonry in the arches had become set, the filling was placed around and over the reservoir, the whole covered with good sod. A trap door, 6 × 8 ft., was left over the suction pipe for entrance, and a float attached to indicate in the pumping room the amount of water in the reservoir.

After the reservoir had been completed, it set for ten days before water was turned into it. During this time there was no leakage to speak of at any point; although there were several barrels of water gathered in the suction pit. This, too, when the water line outside the reservoir was up to the flow line. As the bottom of the reservoir was below the level of the water in the river, no drain pipe was used, the overflow being placed in one side, with the discharge pipe leading directly into the river.

This reservoir has now been in operation for over a year, and during the greater part of this time there has always been water wasting in the river. There has been no scarcity of water for sprinkling purposes, and since the

*Extract from the report of the Committee on Water-Works, presented at the annual meeting of the Illinois Society of Engineers and Surveyors, at Moline, Ill., Jan. 25.

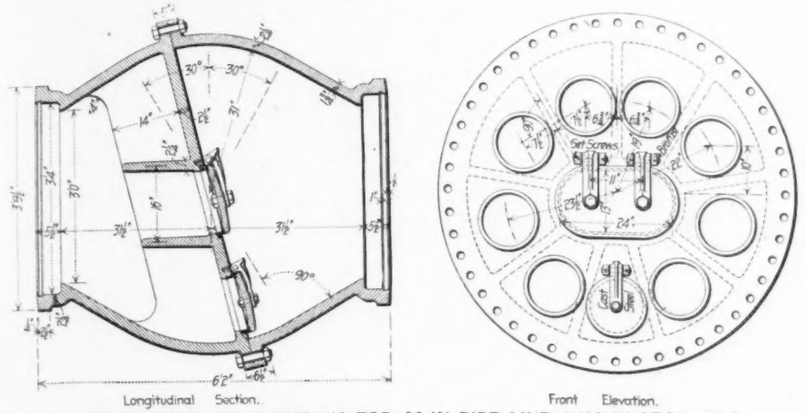
†Of Alvord & Shields, Civil Engineers, Hartford Building, Chicago, Ill.

low-pressure tank was abandoned, general satisfaction has been expressed with the service rendered. The contract price for this work was $3,150, but owing to the difficulties encountered there were extras, which, with the engineering and supervision, brought the total cost to $4,005. This is for the storage capacity of this reservoir cost $14.35 per 1,000 gallons; while that of the Attica reservoir, with a capacity of 500,000 gallons, was $10 per 1,000 gallons storage capacity.

CHECK VALVES WITH MANHOLES FOR A 36-IN PIPE LINE.

The city authorities of Washington, D. C., recently had occasion to use two 36-in. check valves in a pipe line which passes through a well. The water in the well surrounding the valves made it necessary to provide some way of entering them other than by a manhole through the body, as is usually done. Specifications were, therefore, prepared calling for valves so constructed that a man could pass through the pipe line and through the diaphragm of each valve. This was accomplished by making the center opening of the diaphragm large enough for a man to pass through.

This construction is shown in the accompanying



Longitudinal Section. Front Elevation.

CHECK VALVE WITH MANHOLE OPENING FOR 36-IN PIPE LINE, WASHINGTON, D. C.
The Michigan Brass & Iron Co., Detroit, Mich., Manufacturers.

cut. The opening is oblong, 13 ins. wide by 24 ins. long, the extremes of which are semi-circles, as shown by the dotted lines in the elevation. This opening is covered by a bronze-mounted cast-iron flap which constitutes a part of the valve. The other openings in the diaphragm are circular and are also covered by bronze-mounted cast-iron flaps. The bronze rings which face these flaps come in perfect contact with the bronze rings which are screwed into the diaphragm, making a water-tight joint. All the flaps swing on cast steel hinges with bronze connecting pins.

From the illustration it will be seen that the valve is a very heavy piece of work. The castings were made in green sand, although the usual practice is to make large castings of this kind in loam. The valves were designed and built by the Michigan Brass & Iron Works, of Detroit, Mich., to whom we are indebted for the drawings of the valve herewith reproduced.

ECONOMIC RAILWAYS FOR COUNTRY DISTRICTS.*

By E. E. Russell Tratman.†

Where cheap railways for light traffic are to be built, and especially when they are to be operated as independent enterprises, it is important that good engineering skill, good business judgment and good executive ability should be combined in their promotion. Great pains must be taken to adopt the most advantageous location for securing traffic and for operation, while in construction the lowest possible cost must be aimed at. Care must be exercised, however, that the construction is not of such a cheap and flimsy character as to impair the operating capacity of the road at moderate speeds (with due regard to the expected train loads), or to impose heavy maintenance expenses.

About ten years ago, an interesting paper on "The Cheapest Railway in the World" was presented to the American Society of Civil Engineers, by Mr. Arthur Pew. The conditions were to build the very cheapest road that could be built, very little money being available. The line was from Dublin to Wrightsville, Ga., 19 miles, passing through moderately rough country and crossing two rivers and several smaller streams. Convict labor was employed, clearing the forest for a width sufficient for the roadbed, then doing the grading, and then clearing the right of way and making ties from the trees. The contract price for this labor was $1 per day per man. The grading was light, averaging about 4,000 cu. yds. per mile, and cost about 9 cts. per cu. yd. The ties cost about 10 cts. each. The cost for the first 11½ miles, all ready for the rails, was $1,005 per mile for clearing, grubbing, grading, ditching, ties and trestles. Adding the expenses for right of way and for engineering, the average cost was $1,164 per mile. With the 19 miles all built and ready for traffic, with track, stations, water tanks, etc., the cost was $3,441 per mile. It is to be noted that the company did not make the mistake of trying to economize in the engineering, and Mr. Pew stated that it was generally considered that the care with which the location was made was an important element in assuring the construction of the road. Another reason for the low cost was that there were no middlemen to divide the profit. The management did not pride themselves so much on building a cheap road as on doing so much good work at such small expense.

Mr. Pew informs me that he has since built other roads even more cheaply, owing to the following conditions: (1) A smoother country; (2) the lower price of rails; and (3) the use of lighter rails. The very cheapest road that has come under his observation (and which was built under his supervision), cost about $2,300 per mile, all ready for the rolling stock.

Railways of this character have been built in the South Atlantic states, in broken and undulating country, at a cost of $2,500 to $3,000 per mile, the cheaper ones being mainly for hauling lumber. The maximum grades are from 2 to 2.6%, in the direction of the heaviest traffic, and 2.75 to 3.25% in the opposite direction, while the curves are from 6° to 10°. Earthwork is kept as light as possible, and rock cuts are avoided when practicable by shifting the location. The width at sub-grade is usually 12 ft. in cuts and 10 ft. on banks. The grading is done by small local contractors or by men employed by the railway company and directed by a good foreman. State convicts are also employed. The contractors usually bid on the work at about 6 to 9 cts. per cu. yd. for aggregate excavation and filling, without taking haul, waste or barrow into account. The grading on the lighter lines costs about $100 to $200. On a heavier line, with elevations of 200 ft. in 1¾ miles, and 300 ft. in 3 miles, with some extensive cuts and fills, and some rock work, the cost was $650 per mile for grading, with a total of $900 per mile for grading, pipe drainage, trestles, etc. Wooden box culverts are used in light fills, and pipe culverts in larger fills, while for creeks and small streams the grade is kept as low as possible and low trestles are put in. For spans of 30 to 45 ft., the abutments consist of double trestle bents on cribs, these cribs having sheet piling inside and outside.

The engineers for such railways are usually employed by the week or month to locate the line, establish grades, furnish plans for trestles, etc. They sometimes set the center stakes only, but on heavy work or on work done by contract they usually stake out the work in the ordinary way.

For lines of this character the ordinary standard gage should be adopted, although there are some cases where narrow-gage lines have been used with fair success, though they involve break of bulk for all freight. As a rule, little is to be gained by the adoption of a narrow gage, but if it is adopted, then the gage should be really narrow, say 24 ins., and in no case exceeding 36 ins.

In Maine there are seven lines of 24 ins. gage, aggregating 150 miles in length, the longest being 44 miles and the shortest 4 miles in length.

This paper would not be complete without some reference to the electric railways for country districts, although these are built mainly for passenger traffic, and accommodate freight traffic as a side issue. The Philadelphia & Westchester Electric Ry. is 20 miles long, and passes from the city's suburbs through a rich farming country. The grades are 4 to 6%, some of them 3,500 ft. long. The track consists of 58-lb. T-rails on ties 7 ft. long, 5 × 7 ins., spaced 2 ft. c. to c. For carrying milk and farm produce, there are double-truck cars 36 ft. long in the body and 46 ft. over the vestibuled platforms. This road cost about $23,000 per mile, exclusive of building and power plant.

The Dayton & Western Traction Co., extending 25 miles from Dayton, O., to Eaton, passes through a number of small villages and towns in a farming district, in which carriages and wagons were the only means of transportation until this line was built. The track is laid at the side of the National Turnpike Road, and in 22 miles there is but one curve. The maximum grade is 4%, and there are also grades of 3.85% for 2,600 ft., and 3.5% for 1,700 ft. on a long grade six miles in length. There are 19 steel bridges of 10 to 154 ft. span; all built alongside the county highway bridges on independent abutments. One is a through truss bridge, all the others are deck plate girder bridges. The track is laid with 70-lb. T-rails, with girder rails in the streets of Dayton and Eaton, all rails being 60 ft. long. The ties are 7 ft. 6 ins. long, 5 × 7 ins. section, about 80% being white oak and 20% chestnut. The gravel ballast is 6 ins. deep under the ties. The passing sidings are 200 ft. long, and there are two railway grade crossings, both fitted with derailing devices. The power plant comprises two Buckeye tandem compound engines of 250 HP. each coupled directly to a Siemens & Halske dynamo of 250 kilowatts. There are also two Babcock & Wilcox water tube boilers of 250 HP. Double truck cars are used, and the traffic includes passengers, packages, light freight and general freight.

These electric railways are usually built wholly or mainly along existing roads, and the earthworks are therefore very light. Wooden trestles, occasional steel or stone bridges (when highway bridges are of insufficient strength), subways under steam railways, and the necessary power houses, are the principal structures. These electric railways, however, represent a considerably higher cost than the cheap style of railways above noted, for while they have usually but little earthwork, yet the poles and wires represent a considerable expense, and a power plant is a necessity and its first cost is large. Such a plant, too, is often worked uneconomically under the conditions of service, although the economy may be greater in cases where the plant can be utilized for lighting and for general power purposes, as well as for railway service. A low estimate for a line of this character is $12,000 per mile. The cost of the Dayton & Western Electric Ry., already mentioned, was about $16,000 per mile, all complete. This includes the grading, track, overhead work, power plant, buildings, etc., in fact, for the road complete and ready for traffic, but exclusive of rolling stock.

For purposes of comparison, it may be noted that a double track electric line substantially built for fast traffic and having its own right of way, masonry culverts, and a third of a mile of trestle, cost about $31,500 per mile.

Where conditions are such that it is essential to reach the very lowest point of first cost, the steam railway has a more favorable showing, and this is especially the case where the line is built across country. There is, however, a third and intermediate character of railway that may be adopted to advantage where the existing highway afford an easy route with a small amount of grading, bridging and trestling. In this case the line could be built practically the same as the light electric railways, but without poles, wires, or power plant. The power would be furnished by gasoline, oil or other engines, with suitable gearing and connections, mounted in a car and driving one of the trucks or axles. In such a line, probably the very lowest figure for construction could be reached, while the cost of rolling stock and its operation would be materially less than for ordinary steam locomotives and cars.

Appended to this paper is a general estimate of cost per mile for a light country electric railway five miles in length, with a limited amount of traffic:

80 tons of 50-lb. rails, at $35	$2,800
360 angle bar joints, at 85 cts.	306
2,640 ties, at 35 cts.	924
30 kegs of spikes, at $5.10	153
360 rail joint bonds	144
Miscellaneous material	150
Grading	300
Tracklaying, surfacing and bonding	1,320
Teaming and incidental expenses and labor	300
45 cedar poles, at $2.40	108
45 pole arms, at $2.00	90
Overhead wire and material	445
Labor	200
Special work	300
Power plant, at $10,000	2,000
Total cost of construction per mile	$7,540
Power station and car house, at $5,000	1,000
Total cost per mile	$10,540

*Abstract of a paper presented at the annual meeting of the Illinois Society of Engineers and Surveyors, at Moline, Ill.

†Associate Editor, Engineering News.

CONDENSATION OF STEAM IN BLOWER SYSTEMS OF HEATING.*

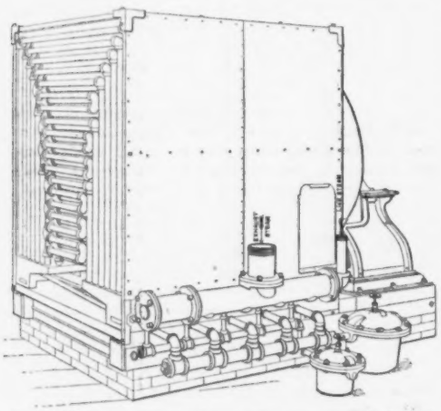
By R. C. Carpenter, M. Am. Soc. M. E.†

The experiments described in the following paper were made for the purpose of determining the amount of heat transmitted under different conditions of velocity by a blower working under conditions similar to that required for hot-blast heating. The blower stands 80 ins. high, has a circular inlet 30 ins. in diameter and a square outlet 26½ by 26½ ins.

The distance from extremity of fan wheel to nearest point of casing is 6½ ins.; to bottom of casing is 18½ ins.; to casing at a point 45 degrees back of bottom, 18 ins. Inner face of blades, plain and radial; outer edge for distance of about 4 ins. curved so as to stand about 1½ ins. back of radius. Estimated radius of curvature, 1¼ ft. Number of blades, 8. Outside diameter of fan wheel, 48 ins.; inner diameter, 32 ins.; width of fan wheel, 16 ins.; from centre, 24 ins.; at outside circumference, 18 ins. It is revolved in such a direction that the cam of the blade is away from the direction of action.

Each section of the heater consisted of three parts; a cast-iron inlet base, an outlet base of similar construction, located on the opposite side, and four series of wrought-iron pipe coils connecting the two, the pipe construction being such that the inner coil of piping is practically the same length as the outer; the intention of the designer being to make the frictional resistance in all the coils equal. Steam is introduced, as nearly as possible, at the top part of each base; the bottom of the base is dropped down to form a receptacle for whatever condensation may form in the base or run back from the side from which steam is introduced.

The heater tested had eight sections. In the tests of the heater, the condensing water, after its discharge from



General View of Heater with Traps and Steam Connections.

the traps, was passed through a cooling coil immersed in a tank of water, and then discharged in a barrel on scales, in which it was weighed. Each of the eight sections of the heater contained, by measurement, 171 linear feet of inch pipe, and, making allowance for the elbows and bends, contained 180.85 sq. ft. of heating surface. Each section was provided with valves on both steam and return pipe, so that any portion of the heating surface could be used as desired. Section 5 of the heater contained a broken fitting which was difficult to remove, and all the tests recorded were made without that section in use.

The blower was driven by a vertical engine capable of developing about 18 HP. The investigation was conducted to determine the following: (a) The effect of change of pressure in the steam coils upon the amount of heat given up to the air, other conditions remaining constant. This was determined from the data obtained from 15 trials, with five different amounts of heating surface and three different steam pressures, namely, 15, 40, and 60 lbs.

(b) The effect of varying the amount of heating surface upon the heat given up to the air, the pressure of steam in the coils and velocity of air through them remaining constant; this was deduced from 15 tests, using five different amounts of heating surface.

(c) The effect of varying the velocity of the air through the coils upon the heat given up by them.

(d) Condensation of steam per hour per sq. ft. of heating surface at the various pressures of steam.

(e) Tests of the blower used under different conditions.

In measuring the velocity of air, two anemometers and several Pitot tubes were used. The cross section of the casing at the entrance of the air to the heater was subdivided into small squares, and the average velocity determined by the anemometer reading was obtained by placing the anemometers successively in these various sections and taking the average of the results. The Pitot tube was used to determine the velocity in the discharge pipe at some little distance from the fan wheel and in a position where the velocity was too great for the use of the anemometer. The two anemometers used differed considerably in their readings. Both instruments were calibrated.

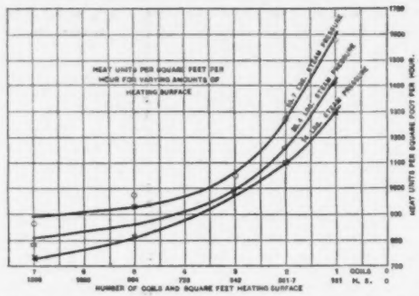


Fig. 1.—Effect of Varying the Amount of Heating Surface on Transmitted Heat.

The results of each test showed a very considerable variation in velocity of discharge in different parts of the same cross section of the outlet. The peripheral speed of the fan being 6,910 ft. per minute, the velocity of the air varied from 3,190 as the average in the top sections of the outlet to 5,160 ft. per minute as the average in the bottom sections. The variation of the sections from side to side was less, being from 4,430 at one side, to 3,630 at the centre. The highest velocity was found nearest the bottom of the outlet and on the side opposite the inlet of the fan.

Effect of varying the area of outlet upon the horse-power required to operate the fan, and also upon the air delivered: The amount of power required when the outlet was entirely closed was 3.5 horse-power; when the outlet was fully open, 11.6 horse-power; the fan running constantly at a speed of 500 revolutions per minute.

During all the tests the air was drawn in at a temperature of 70° Fahr. by suction, and discharged freely into the atmosphere. The amount of air discharged was almost exactly proportional to the speed. The writer gave as a rule for determining the capacity of a fan of usual proportions, at the last meeting of the Society, the following: "The capacity of a blowing fan, expressed in cubic feet of air delivered, is equal to the cube of the diameter of the fan wheel in feet multiplied by the number of revolutions multiplied by a coefficient having a value depending upon the back pressure of from 0.4 to 0.6." Multiplying the cube of the diameter of this fan wheel by the number of revolutions per hour, we find that the results should be multiplied by 0.555 to give the correct discharge.

The effect of varying the number of coils in use, and also the steam pressure, on the heat absorbed by the air per square foot per hour is shown in Figs. 1, 2, and 3. From this it is seen the amount of heat transferred per square foot of surface diminished rapidly with increase in the number of sections from one to three (4 to 12 coils), after which the transfer of heat remained essentially constant.

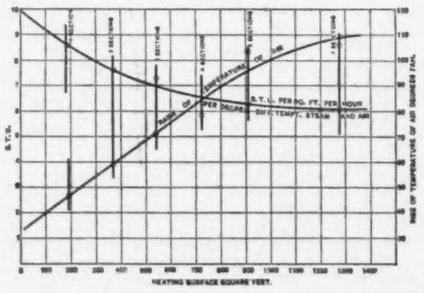


Fig. 2.—Diagram Showing B. T. U. per Square Foot per Hour per Degree. Difference Temperature Steam and Air, for Various Amounts of Heating Surface, Steam Pressure 13 to 14 lbs., Revolutions of Fan 400 per Minute, Air Velocity 450 feet per Minute.

A series of tests were made, operating the fan at different speeds, the results of which are shown in Fig. 4. From this diagram it is seen that the heat transmitted varies nearly with the square root of the velocity of the air, and expressed in thermal units is approximately equal to 150 + 33 times the square root of the number of revolutions per minute.

Fig. 2 shows the relation between the heat given off, expressed in British thermal units per square foot per hour, for each degree difference in temperature between the steam and the air for various amounts of heating surface. The same diagram also shows the rise of temperature of the air in passing through the coils, due to different amounts of heating surface. During all the tests shown on this diagram the steam pressure was maintained between 13 and 14 lbs.; the fan was operated at about 400 revolutions per minute, thus giving an air velocity of about 450 ft. per minute for the air passing the heating coils. From the scale on the left of the diagram it is noticed that the number of heat units per degree difference of temperature transmitted by the heater per square foot per hour, varies from something over 8.5 when one section of the heater (4 coils) was in use, to slightly over 6 when seven sections (28 coils) were in use. The rise in temperature of the air shown by the scale on the right varies from 47 to 108°.

Fig. 3 shows the relation between the temperature of the discharged air, the steam, and the entering air for different amounts of heating surface, the fan speed being maintained at 400 revolutions, the velocity of entering air at about 450 ft. and the steam pressure from 13 to 14 lbs. It is noted by this diagram that the temperature of air increases rapidly with an increase in heating surface up to about three sections (12 coils), after which it increases slowly.

Fig. 5 shows the relation between the temperature of entering steam and the heat units given off per square foot per degree of difference of temperature per hour. It will be noted from this diagram that the heat transfer per degree difference of temperature was more active at the lower temperatures of steam than at the higher. This is seen to be the case for each series of tests in which different amounts of heating surface were used. The difference, however, was not so marked during the series when

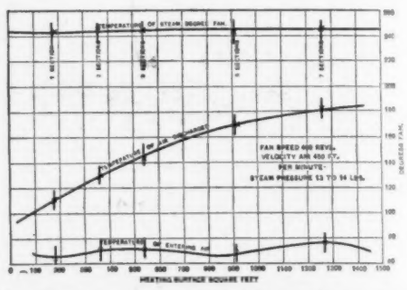


Fig. 3.—Diagram Showing Relation Between Temperature of Discharged Air and Heating Surface.

five sections were in use, which was probably due to some existing condition that was not, at the time, taken into account. Each curve in this diagram shows a series of tests made with different amounts of heating surface.

The accompanying table gives the average results of the various tests discussed. Tests numbered from 1 to 15 were made with the fan running at about 400 revolutions per minute, and a pressure in the discharge pipe of about 0.35 in. of water and an equivalent opening of 20 × 20 ins.

Conclusions.—From the fact that these tests represent only the results to be obtained by fans working under the same conditions, it is not safe to draw broad conclusions as applying to all cases with accuracy. The general conclusions which can be drawn from these tests seem to be as follows:

The effect of change of pressure of the steam which is used in the steam coil increases the total amount of heat given off, but does not increase the heat transfer in proportion to the increase of temperature of the steam.

The effect of increasing the velocity of the air increases its capacity to take up heat an amount which increases at a greater rate than the square root of the increase of velocity. This would indicate that the capacity of a given system for hot-blast heating would be increased by increasing the speed of the fan, both as to the quantity of air supplied and as to the amount of heat taken up. The amount of heat taken up, is not, however, sufficient to keep the air at a constant temperature, although the fall in delivery temperature, due to increase of velocity, may be slight. This is illustrated in tests Nos. 16, 17, and 18. In each of these tests the air was received at practically the same temperature, that of 73°; the same heating surface was used; the velocity was in the three tests, respectively, 246, 482, and 664 feet per minute; the corresponding discharge temperature being, respectively, 163, 152, and 150° Fahr., which shows a very small drop in delivery temperature due to an increase in velocity of air to nearly three times its first velocity.

The condensation of steam per hour varies with the

*Condensed from a paper read at the New York meeting of the American Society of Heating and Ventilating Engineers, Jan 25, 1900.

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amount of heating surface and the number of coils over which the air flows. It would seem that the conclusions from the test would be that the limit of economic heater construction would limit the number of coils with which the air comes in contact to some point in the region from 12 to 20, as the steam which is condensed for heating purposes is obtained principally from the coils mentioned. The amount of steam which would be condensed by passing the air over 3 to 4 sections (12 to 16 coils) with entering air at zero temperature and discharge air about 140° would be, it is computed, equal to 1.3 lbs. of steam per square foot of heating surface per hour (equivalent to about 1,260 heat units), from a heater situated under

AVERAGE RESULTS OF TESTS OF CONDENSATION OF STEAM IN BLOWER SYSTEMS OF HEATING.

	One section.		Two sections.		Three sections.		Five sections.		Seven sections.		Four sections.	
Number of run	Heating surface, 180.85 sq. ft.		Heating surface, 361.7 sq. ft.		Heating surface, 542.6 sq. ft.		Heating surface, 904.4 sq. ft.		Heating surface, 1,266 sq. ft.		Heating surface, 723.4 sq. ft.	
	1.	2.	4.	5.	7.	8.	10.	11.	13.	14.	16.	17.
Mean pressure in coils, lbs.	12.62	35.5	13.1	35.5	14.0	34.5	13.0	34.0	13.2	53.2	13.0	12.5
Temperature of steam, °F.	244.1	280.5	246.3	281.0	245.0	280.0	245.764	278.937	246.3	291.0	245.0	244.0
Total steam condensed per hour, lbs.	263	294	458	495	1,075	1,091	931.8	1,014	970	1,088	618	769
Steam condensed per hour, lbs. per sq. ft.	1.40	1.64	1.27	1.37	1.00	1.19	1.04	1.12	0.76	0.865	0.72	1.06
B. T. U., per hour, lbs. per sq. ft.	1,340	1,413	1,106.5	1,267	986	963	991.0	1,053	703.3	852.0	673.3	829.8
Temperature of air received, °F.	65.0	65.9	71.17	72.47	74.0	73.0	66.25	70.8	77.0	78.0	73.33	73.5
" " delivered, °F.	112.0	130.05	138.7	144.7	145.5	153.0	169.75	191.5	182.5	215.0	152.3	162.75
" " mean, °F.	88.5	98.5	104.93	108.7	110.0	113.0	118.0	131.0	129.5	146.5	112.8	118.12
" " increase, °F.	47.08	41.09	33.8	36.3	35.5	40.0	52.75	60.7	53.2	68.5	39.7	44.37
Expansion of air by heating	511	1,085	507	617	506	488	456	430	486	452	404	404
Velocity of air entering coils, ft. per min.	400	485	404	480	400	404	400	402	400	402	404	404
Revolutions of fan per minute	5,026	5,026	5,070	5,026	5,026	5,040	5,026	5,050	5,026	5,040	5,070	5,070
Peripheral speed of fan, ft. per min.	215.5	236.1	218.3	248.9	171	207	179	208.4	148.5	144.5	133.3	131.2
Difference temp. bet. steam and entering air	135.6	192.0	146.2	172.3	135	185.5	127.5	161.42	116.3	159.6	133.3	128.3
Difference temp. per hr. for diff. temp (14), per deg.	7.5	6.6	6.34	6.73	5.78	4.85	6.32	6.30	6.15	6.05	5.83	4.82
B.T.U. per sq. ft. per hr., for diff. temp (15), per deg.	8.63	7.4	7.56	6.59	7.258	5.475	6.008	1.007	1.140	937	1,055	1,275
Probable B.T.U. pr hr. entering air zero, pr sq. ft. H.S.	1,615	1,655	1,308	1,400	1,335	1.53	1.67	1.05	1.19	0.965	1.02	1.33
Probable steam co.d., entering air zero, per sq. ft., lbs.	1.67	1.72	1.43	1.50	1.38	1.53	1.67	1.05	1.19	1.02	1.09	0.845
Volume of air received, cu. ft. per hour	882,000	829,000	884,000	835,000	865,000	834,000	781,000	762,000	736,000	800,031	707,000	18,950
Velocity in discharge duct, ft. per min.	2,800	3,090	2,740	3,140	2,700	3,110	3,150	3,115	3,140	3,150	3,160	4,210
Ratio velocity of air to peripheral velocity of fan	0.565	0.611	0.622	0.645	0.682	0.618	0.62	0.615	0.622	0.625	0.625	0.59

conditions similar to those which existed at the time of making the test.

Taking the specific heat of air as 0.238, it will require 33.3 B. T. U. to warm 1 lb. of air from a zero temperature to 140°. From this the amount of heat given off from one square foot of heating surface would warm 37.8 lbs. from zero to 140°, or it would warm 44 lbs. from zero to 120°. The volume of air for ventilation purposes may better be calculated at about the temperature of use, which is usually 70°, at which temperature each cubic foot weighs 0.075 lb. Reducing these results to cubic feet on the above basis, we find that one square foot of

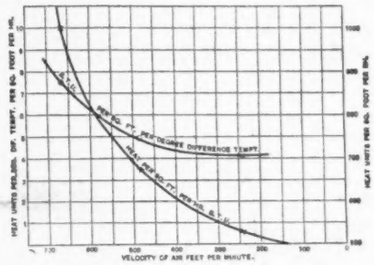

Fig. 4.—Effect of Varying the Velocity of Air on the Amount of Heat Liberated, Steam Pressure 13.3 lbs., Entering Air 73° Fahr.

heating surface would warm 504 cu. ft. (measured at 70°) per hour from zero to 140°, or 587 cu. ft. from zero to 120°. This is, respectively, 8.4 and 9.8 cu. ft. per minute.

For many purposes it is convenient to reckon the heating capacity as based on the equivalent lengths of inch pipe in the heater. To obtain this we would need to divide the above results by 2.9. Reducing, as explained, we find on this basis that the equivalent of each linear foot of one-inch pipe in the heater, would warm 2.9 cu. ft. of air from zero to 140°, or 3.38 cu. ft. of air from zero to 120° per minute.

The various results which have been given show the effect of varying different conditions with respect to capacity and efficiency of the blower used.

The capacity, when delivering into free air, is equal

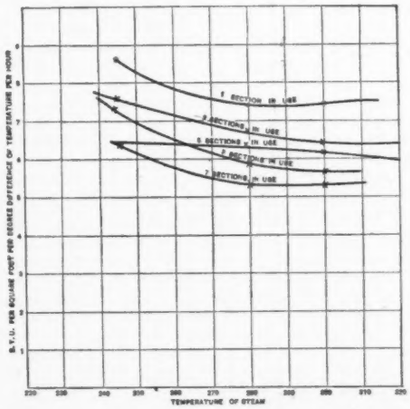

Fig. 5.—Showing Relation of Heat Transmitted per Degree Difference Temperature to Temperature of Steam.

to the cube of the diameter in feet multiplied by the number of revolutions multiplied by the coefficient 0.555.

For other openings than that for free delivery, we find the following coefficients for $D^3 n$

Opening, ins.	Coefficient.	Pressure.*
26 × 26	0.555	0
20 × 20	0.525	0.35
18 × 18	0.437	0.56
16 × 16	0.344	0.82
14 × 14	0.265	0.91
12 × 12	0.195	1.15
10 × 10	0.133	1.37
8 × 8	0.100	1.54
6 × 6	0.060	1.67
2 × 2	....	1.87

*Inches of water above atmosphere for 400 rev. of fan.

The investigations show that the pressure produced by the fan can be expressed by the following formula, in which v = velocity of tip of fan in feet per second; o = the area of the outlet in square feet; i = the area of inlet in square feet (= 4.7 sq. ft. for the condition when the barometer reads 29.92 ins. of mercury).

$$p = \left\{15.3 \sqrt{\frac{v^2}{6{,}400} + 58.62 - 117.2}\right\} \left\{1 - \frac{o}{i}\right\}^2.$$

THE ECONOMICS OF LONG DISTANCE ELECTRIC POWER TRANSMISSION.

By Alton D. Adams,* M. Am. Inst. Elec. E.

There has recently come to the hands of the writer the prospectus of a company which wishes to raise funds for the development and electrical transmission of a water power in Western Illinois. The great bulk of the population to whose use it is desired to devote this power is located in cities 40 miles distant from the point where it is to be developed. It is seriously proposed to develop and transmit the water power in question over a distance of 40 miles and sell it in competition with steam power, at points in Western and Central Illinois; and investors are asked to furnish the capital for this enterprise.

Did the above proposition stand an isolated instance, it might well be passed without comment as the chimerical dream of an enthusiast or the obviously fraudulent scheme of a promotor. Unfortunately, the number of propositions similar to the above that are now appearing shows that in many quarters there is current an idea that, given a comparatively cheap source of power it may be profitably conveyed, by the magic of electrical transmission, for a very long distance, and sold in competition with steam power.

As a general proposition nothing could be further from the truth, in spite of the matter that now and then gets into print concerning the electrical transmission to distant cities of power developed from great water falls or banks of waste coal at the mines. It is true, of course, that electric energy can be transmitted over distances that are practically limited only by the possible investment of the promoters. It is equally true that the distances are quite limited over which power can be electrically transmitted and sold at a profit in competition with steam power generated from coal at ordinary prices. The higher the price of coal or the greater the cost of power production, the longer is the distance over which a cheap power may be profitably transmitted. So great, however, is the investment necessary for long distance electrical transmission and so large the losses of power involved, that with absolutely free mechanical power at the start, the distance to which it can be electrically transmitted and sold at a profit in a district where fuel is as cheap as in Central Illinois, is probably less than 25 miles.

Let the 40-mile transmission proposed in the above prospectus be considered in detail to get an idea of the actual investment required and of the losses incident in the electrical transmission proposed. Starting first with 1 E. HP. delivered as direct current to low pressure distribution circuits in the town or city where it is to be used, note the total capacity and efficiency of the electrical equipment involved. The chain of electrical elements, beginning at this point, includes a rotary converter, step-down transformer, line, step-up transformer and dynamo. Average efficiencies for each are, rotary converter 90%, transformers each 95%, and dynamo 90%. Any desired loss may be assumed for the line but an efficiency of 90% is fair for the present case. The total efficiency of the transmission is, therefore, the product of .90 × .95 × .90 × .95 × .90 = .65%.

Hence, for each horse power delivered by the rotary converter to the distribution lines, the dynamo at the distant generating station absorbs 1 ÷ .65 = 1.53 HP. Taking the capacity of the rotary converter as 1, the capacity of the step-down transformer which supplies it is 1. ÷ .90 = 1.11; for the step-up transformer, allowing 90% efficiency for the line, 1.11 ÷ (.95 × .90) = 1.3; and the capacity of the dynamo is 1.3 ÷ .90 = 1.44 times that of the rotary converter. The combined capacities of the rotary converter and the dynamo are 1 + 1.44 = 2.44 times that of the rotary; and of the transformers, 1.11 + 1.3 = 2.41 times that of the rotary. For each horse power delivered by the rotary to distribution lines, the step-up transformer at the generating station must deliver 1.3 HP. to the transmission line.

The weight of conductors necessary to transmit this rate of work to the step-down transformer, at the rotary converter, will vary inversely as the square of the volts at the line terminals of the

*Box 1377, Boston, Mass.

step-up transformer, and it is therefore desirable to adopt as high an electric pressure for the transmission as is practical. Climatic conditions have a marked influence on the number of volts it is practical to employ for transmission lines. It is an open question whether more than 10,000 volts can be regularly and satisfactorily used on a 40-mile line in a section having the moist air and heavy rainfall of the Mississippi Valley, and actual experience is lacking to show the amount of trouble to be expected on a line of this extent and pressure in such a territory. Assuming, however, as is probably the case, that no very serious difficulty would be had with a line 40 miles long and working at 10,000 volts pressure, the necessary weight of copper wire to transmit each 1.3 HP. delivered to the line by the step-up transformer, at an efficiency of 90%, is about 380 lbs.

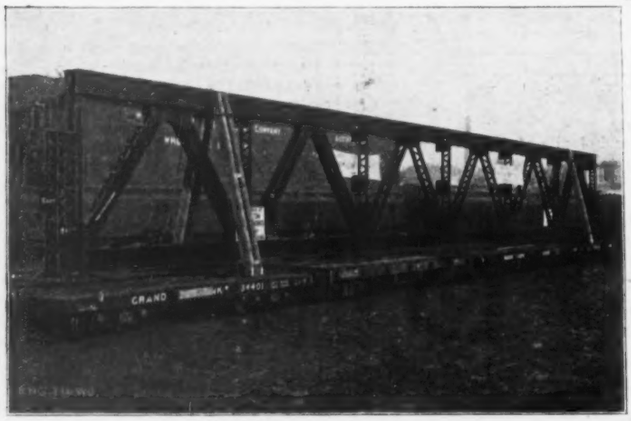

FIG. 1.—VIEW OF 40-TON LATTICE GIRDER MOUNTED ON FLAT CARS FOR TRANSPORTATION.
Hamilton Bridge Works Co., Hamilton, Ont., Builders.

If it should prove practically possible to operate the above line at double the pressure named, or at 20,000 volts, the weight of copper conductors per horse power delivered by the rotary converter reduces to 95 lbs., one-quarter of the above amount.

The cost of a pole line for these conductors per horse power delivered, is a variable quantity, depending to a large extent on the total amount of power transmitted, but may be taken at approximately $4 per HP. Dynamos and rotary converters may be fairly taken to cost about $25, and transformers $10 per horse power capacity. An investment in electrical machinery and lines of $(2.44 \times 25) + (2.41 \times 10) + (380 \times .20) + 4 = \$165.1$ per electrical HP. delivered to local supply lines is therefore necessary for the 40-mile transmission, at 10,000 volts, taking copper line wire at 20 cts. per lb. If the line pressure can be raised to 20,000 volts, the item for copper reduces to $95 \times .20 = \$19$, and the investment per delivered horse power is then $108.10.

No satisfactory estimate of the cost to develop the particular water power in question can be made without a large amount of data that is not given. Judging by the investment found necessary at various water powers in favorable locations, the total cost of development, including dams, short canals, water wheels and connections at falls or steep rapids, under 20 ft. in height, in favorable locations, should be somewhere from $75 to $150 per HP. developed. Considering the prices paid at a number of well situated water powers, which usually range from $10 to $25 per horse-power year, a charge of $15 per horse-power year for power delivered to the dynamos at the generating plant may be fairly assumed. Since, as found above, for each horse power delivered to distribution lines by the rotary converter, 1.53 HP. must be absorbed at the dynamos, the actual cost of water power for each horse-power year supplied to local lines is $15 \times 1.53 = \$22.95$.

The electrical transmission plant will require two buildings, one for the generating station, another at the place where the distributing equipment is located, but as these two buildings may be taken to approximately equal in cost a single building for a steam plant of equivalent power at the point of consumption, any estimate for them may be omitted.

The labor cost of operation for the electric generating and receiving plants, 40 miles apart, and the care of their connecting line may be assumed to equal the labor item in the operation of a steam plant having equivalent power, though this assumption is very favorable to the transmission system.

It only remains now to consider the item of fuel for the steam plant. In Central Illinois, steam coal, of a quality that, with good boilers and compound condensing engines, will develop a brake horse-power-hour on a consumption of 2.5 lbs. can probably be had at less than $2 per ton; but it is here assumed to cost that amount. The fuel cost for a year of 3,000 horse power hours at the engine shaft is therefore $(2.5 \times 3{,}000 \times 2.) \div 2{,}000 = \$7.50$. Assuming, as before, an efficiency of 90% for the dynamo driven by this engine, the fuel cost per electric horse power supplied to local lines for distribution is $7.50 \div .90 = \$8.33$ per year. Compound condensing engines with good boilers and all fittings can be erected in large sizes for less than $54 per brake horse power capacity, and the cost of such steam plant per horse power output at electric generator terminals is therefore not more than $54. \div .90 = \$60$. Allowing $25 per HP. for dynamos, the total investment for machinery at the steam driven electric plant is $\$60 + \$25 = \$85$ per horse power delivery capacity to electric distribution lines.

Comparing now the long distance electric transmission with the steam and electric plant, the transmission line and machinery costs $165.10 at 10,000 volts, or $108.10 at 20,000 volts per delivery capacity of one electrical horse power, while the steam driven electric plant at the place of use costs but $85 for the same capacity. For each horse power year delivered to local distribution lines the charge to the long distance transmission system for water power alone is $22.95, while the charge to the steam driven electric plant is only $8.33 for fuel. Supposing, therefore, that a good water power is already developed and can be had at the wheel shaft for $15 per year, the cost to a transmission system, for a distance of 40 miles, is $22.95 \div 8.33 = 2.7$ times as great as the fuel cost in a steam plant to deliver the same amount of electric energy at the point of distribution.

In addition to the great disadvantage in the matter of water power and fuel consumption, the long distance electric transmission system must pay interest, depreciation and repair charges on from $108.10 \div 85. = 1.27$ to $165.10 \div 85. = 1.94$ times as great an investment for the transmission as for the local system. Those familiar with high pressure electric apparatus and lines can hardly doubt that the rate of depreciation and repair charges on them would be as great as for the steam driven electric plant.

TRANSPORTATION OF A 130-FT. LATTICE GIRDER BY RAIL.

The accompanying engravings show a lattice girder 130 ft. long, and weighing 40 tons, loaded on railway cars for shipment from the bridge works to the point where it was to be erected. Fig. 1 shows the girder very plainly, and also the manner of supporting it on the five flat cars on which it was transported. Fig. 2 shows the same girder being hauled under a highway bridge about two miles from Hamilton, Ont., which the girder cleared by only a few inches. This picture is also interesting for the great number of bridges which it shows in a small space, and because it shows the locality of one of the worst accidents in the history of American railways. The waterway which the bridge crosses is the Des Jardines Canal, and the through plate girder span with the masonry abutments occupies the site which was occupied by the bridge which failed under a train on March 17, 1857, killing 60 and injuring 30 passengers. Not including the truss on the cars there are two railway and two highway bridges in view, the second highway bridge being just beyond the plate girder bridge occupied by the train with only its top chord and tower legs visible.

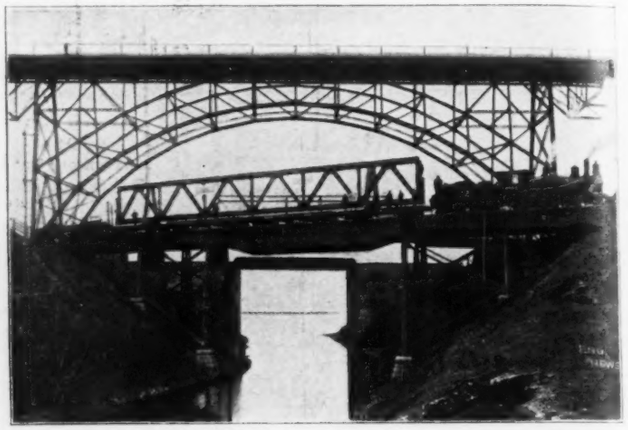

FIG. 2.—VIEW OF BRIDGES OVER DES JARDINES CANAL, SHOWING 40-TON LATTICE GIRDER IN TRANSIT BY RAIL.

The lattice girder shown loaded on the cars, as already stated, weighs 80,000 lbs. It is 130 ft. long and 14 ft. 9 ins. deep, and stands, loaded on special low flat cars, 19 ft. 3 ins. above base of rail. The girder is one of a pair which are being erected for the Canadian Pacific Ry., Mr. P. Alexander Peterson, M. Am. Soc. C. E., Chief Engineer, for a single track deck bridge over the Credit River, about 25 miles from Toronto, Ont. These girders were built by the Hamilton Bridge Works, Hamilton, Ont., Mr. Henry Szlapka, Engineer and Manager.

REVIEW OF EXPERIMENTAL DATA ON IMPACT TESTS OF MATERIAL IN TENSION *

It may be said in general that the main problems for experiment are those in which the deformation exceeds that at the elastic limit. The conclusions from a purely mathematical treatment, usually confined to elastic deformation, are amply confirmed by tests made within the elastic limit; and confirmed also by tests up to rupture on materials whose elastic limit approaches the breaking strength. While it is highly important that theoretical considerations should be kept in mind in arranging and interpreting experiments, yet the solution of the main problems relating to impact must depend chiefly upon experiment, concerned as they are with total resilience. There is, for example, strong evidence pointing to the fact that certain materials, and other materials under certain conditions, vary greatly in their resilience according to the rapidity of application of the energy to the specimen. In the investigation of the influence of this and numerous other elements lies the work of experimenta-

*From a preliminary report on the present state of knowledge concerning impact tests, presented at the second annual meeting of the American section of the International Association for Testing Materials, by Professor W. Kendrick Hatt, of Purdue University, and Prof. Edgar Marburg, of the University of Pennsylvania.

tion, the end of which should be the framing of adequate specifications for tests.

The early experiments of Tredgold, Hodgkinson, Willis and Galton are well known. The laws of impact for cast-iron beams were determined, and the proportionality of resilience to volume and the effect of the inertia of the beams noted. The later experiments of Kirkaldy, Uchatius, Maitland and Estrada, on ductile materials, have resulted in increased knowledge, although the data are too meager for formulation; or even for the reconciliation of apparent contradictions.

As the speed at which the ordinary testing machine is run is increased, the ultimate strength and elastic limit seem slightly to increase, and the elongation to decrease; although, for tests of from about one to six minutes' duration no differences can be measured which are greater than the ordinary differences in quality of bars cut from the same plate. However, no extension of the facts gained from observations upon the effects of differences of speed of the ordinary testing machines can be applied to cases of impact.

The following is a brief and incomplete review of the more recent experiments:

Kirkaldy, 1862, found that wrought iron specimens broke under loads suddenly applied without impact with 82% of the load under slow tests. Uchatius, 1874, noted the increased total energy required to break a bar under a number of light blows compared with that required when broken with a single blow. Maitland, 1887, showed that in the case of unhardened gun steel the ultimate elongation was increased by impact. The specimens were 2 ins. between shoulders, and broke in slow testing at 58,000 lbs. per sq. in. with 27% elongation. The elongation under shock was 47%, when shock was produced by a falling weight. Specimens were also screwed into plugs fitting in a strong tube and broken by exploding gunpowder and guncotton between the plugs. The ultimate elongation was then 47 to 62%. The increased elongation is probably explained by the more uniform distribution of the elongation over the entire length of the specimen instead of its localization at a single neck. Estrada, 1893, made tests in longitudinal impact on nickel steel, armor plate, bridge steel and iron merchant bar, in test pieces of the same size as in slow tension tests. Tests were made at varying temperatures under the blow of a 100-lb. hammer falling through heights varying from ½ to 25 ft. Accompanying tests were made in slow tension. A large amount of the energy of the hammer was absorbed in the apparatus. Rupture was brought about by a number of blows. The ultimate elongation under shock with a number of blows was about two-thirds greater than in the case of slow tension. The contraction of area remained about the same.

Recently, experiments in longitudinal impact were made in Austria by Captains Kuczera and Reinisch, on metals for gun carriages. The rods were of 3-16-in. diameter and were subjected to light blows at temperatures of 68° and — 4° F. Contrary to other experiences, these rods withstood a greater number of blows and developed greater extension at the lower temperature. Rupture of transverse nicked bars, on the contrary, was produced with fewer blows at the lower temperature.

In the "Report of the French Commission," Le Chatelier has two reports which furnish data upon impact. The first, on the influence of duration of test; and the second on the effects of temperature. The main part of the first report deals with tests too slow for impact action. He notes the property which certain materials possess of adjusting themselves to a load, so that the elongation increases to a limiting value at the end of long periods; and the further property whereby the load at rupture increases with tests of shorter time. The latter is especially marked in the case of zinc which ruptured for a 60-minute test under less than half the load producing rupture in one minute. Steel, iron, copper and aluminum did not exhibit this characteristic in any marked degree. In the case of copper, the effect of high temperatures (200°, 350° and 440° C. were used), is to augment the influence of high speed in producing higher values of both ultimate load and ultimate elongation. The effect of the rate of application of the load upon the elongation is variable. Opposite results were found for materials of different degrees of hardness and for stresses of different degrees of intensity. Tests by Barba, Privat, and Le Chatelier, on wires broken with speeds varying between 11 minutes and 4 seconds, showed that for metals of small contraction of area, both the per cent. of elongation, and ultimate load increases with increase of speed; and that for metals of large contraction of area like soft steel, the elongation decreases as the speed increases, down to a duration of one minute, but that for tests quicker than one minute the elongation increases again.

Referring to impact proper, it was noted that, in the case of copper, a given reaction is not accompanied by as great an elongation under shock as under a steady load. The tests of M. Considère on soft iron wire are quoted to show that when the ultimate elongation is the same under slow test and shock, a given elongation results in a much greater reaction in the case of shock.[1] The latter observer measured the reaction accompanying a given elongation from a falling weight by hanging the test wires to a spring.

In the second report on the influence of temperature, Le Chatelier, in addition to investigating the effect of temperature on the results of slow tests, obtained the effect of temperature on quick tests, and discusses fragility at low temperatures. From 100° to 250° C. quick tests gave a less ultimate load and a greater per cent. of elongation than slow tests at the same temperature. Above 300° C. the reverse occurred. While lack of shock-resisting capacity at the lower temperatures depended on the texture of the metal, it seemed that the texture played no part in brittleness at temperatures above 60° or 80° C., at which temperature the fracture of all grades of iron and steel was fibrous when at ordinary temperatures the fracture was coarse.[2] The contraction of hard and soft steel approached equality as the temperature was raised. The temperature of greatest brittleness depended on the speed of test. That is, while in slow tests the resilience was at least at 300° to 350° C., the resilience under shock was least at about 500° C.

With slow tests, low temperatures give increased elongation,[3] but shock tests show less elongation at low than at normal temperature. The experimental evidence of decreased shock resistance at low temperatures is large. Thus, Sandberg, 1867, in the case of iron rails, found a diminution of shock resistance at 12° C. to ⅓ to ¼ part of that at 28° C., the deformation being ¼ part of that at 28° C.

M. Bernadou, for both soft steel and hard steel in flexure, observed a greatly decreased resilience under shock at — 60° compared with + 15° C., the decrease being less for hardened steel. These results were confirmed by Le Chatelier. At 100° C. the elongation increased. A nicked steel bar which broke without deflection at 15° C. gave a silky fracture at 100° and then only broke after pronounced bending.

Under shock, then, either a low temperature or a high temperature will develop a minimum resilience. A temperature of maximum resilience exists between these two, which is higher than the normal atmospheric temperature.

Le Chatelier remarks, it is evident that the resilience under slow tension is not a true measure of the shock-resisting capacity of materials at different temperatures; since in the case of slow tension the per cent. of elongation increases as the temperature is lowered, whereas in shock the reverse is true. At very low temperatures under shock there seems to be elongation only at the point of rupture.

Le Chatelier further notes that at ordinary temperatures, as the speed of the machine increases the ultimate load increases, but the yield points are raised more rapidly. Thus, as the speed increases the stress-strain curve becomes flatter and the elongation is confined to the weaker parts of the bar. The tendency of a bar broken quickly to form knobs is also referred to. Le Chatelier observed also the effect of low temperatures at a given test speed, in elevating the elastic limit toward the ultimate strength; and remarks that any cause, whether low temperature or quick speed or phosphorus which increases the ratio of the elastic limit to the ultimate strength will tend to produce brittleness. Tests with tempered wire showed that the resilience was much less affected by speed than in the case of annealed wire.

A series of tests in longitudinal shock, with accompanying tests in slow tension, has been made at Purdue University during the past two years on iron and steel wires from ⅛ to 1/16-in. in diameter, ranging in length from 4 to 9 ft. Results from 62 specimens have been obtained. The experiments will be continued next year on an improved machine, and with material more homogeneous than that used heretofore. The machine is of a type previously noted, the hammer being hung on the specimen and impact taking place at the upper head. The hammer varied from 845 to 1,230 lbs., the range of motion being from ¼ to 7 ft. The specimens were ordinarily broken with one blow, so that the conditions were met of (1) a heavy hammer of low velocity; (2) large inertia of everything except the specimen; and (3) the use of a single blow. The anvil on which impact occurred at the upper head consists of two oak pieces 4 × 4 ins. in section, bridging 20 ins. clear span between uprights of machine, supporting a cast-iron block 14 × 18 ins. × 6 ins. thick, which in turn supported a steel block 4 × 4 ins. in section and 14 ins. long.

Some of the energy was absorbed at the anvil or bridge, but as the maximum reaction developed in the wire was 6,000 lbs. and the deflection at the bridge did not exceed 1-16-in., whereas the elongation of the specimen was usually 12 to 18 ins., the proportion of work absorbed was small. Thus, with 14 ins. elongation of specimen it would be less than 1%.

A pencil attached to the hammer describes a curve on the surface of a revolving drum, whose speed is determined by the record of a tuning fork. The total elongation of the specimen is thus recorded on the drum, as well as the velocity of the descending weight before and after impact. The total work done on the specimen and at the bridge is equal to the loss of kinetic energy of the hammer plus the weight of the hammer into the elongation of the specimen, the friction on the guides, and the work done in compressing the wedges being neglected. By drawing successive tangents to the velocity displacement curve recorded on the drum, and determining the acceleration at successive points, a load elongation diagram, or stress-strain curve is obtained.

The specimen is held by conical wedges, fitting into a proper hole in cylindrical steel bushings.

In the tests referred to, the wedges were driven tightly, and no slipping of the specimen in the wedges could be detected. A summary of the observations shows that the ultimate elongation, contraction of area and resilience were not different for Norway iron and medium steel wire about ⅛-in. in diameter under slow loading and impact. A greater elongation and contraction of area occurred under shock in the case of hard steel wire, and in the case of softer wire of ⅛-in. in diameter. The effect of temperature on elongation and resilience of Norway iron was marked.

One specimen broke in two places, and in other cases more than one neck developed in the specimen. In impact on wires of smaller diameter the elongation in the different foot-lengths varied apparently without any regularity, while in the case of slow-tension tests on the same material the elongation decreased regularly on each side of the fracture. In the case of thick wires the elongation was as uniformly distributed in slow as in rapid tests. Tests of Norway iron at low temperature developed knobs in the specimen, the elongation being confined to the length between knobs. These knobs were not noticeable at 210° F. The erratic behavior of some specimens indicated clearly that the material was not homogeneous. Detailed results will be published when the investigation is sufficiently advanced.

Tension tests under impact have been carried out by Prof. Martens, but have proved so far of little promise. Tension tests were made on round bars 0.8-in. in diameter, of soft steel and bronzes. The deformation became less as the energy of the blow became greater. In general, the appearance of the surface of rupture was found alike in all respects under impact and slow stress. By rupture with several blows, the elongation was frequently greater than under slow tension.

ROOF HYDRANTS AND FIRE-PROOF SHUTTERS receive high commendation in the report of the Philadelphia Fire Underwriters' Association on the destructive fire of Nov. 29, 1899, at 8th and Filbert Streets, in that city. This fire began in the large department store of Partridge & Richardson, and extended to the publishing house of J. B. Lippincott Co., both of which buildings were gutted and practically destroyed. After referring to the faulty construction and equipment of these building to resist the spread of flames, the report says:

South of the Partridge & Richardson risk in which the fire started, stands the large department store of Lit Bros., being four and five stories high with a ground floor area of 34,535 sq. ft. This risk was directly exposed to the heat generated by the burning of the two buildings named, having windows facing both the buildings, which, however, where most exposed had been protected with standard fire shutters approved by this association. That risk is also composed of several buildings thrown into one, being of ordinary construction and having many unprotected stairways and elevators, but equipped with automatic sprinklers, having for supplies elevated tanks, as well as a pump and a connection on the street for use of fire department steamer. In connection with this same pump (which was a Deane Duplex of a rated capacity of 900 gallons per minute, and derived its supply through two 6-in. connections from a 10-in. city main on 8th St. and a 6-in. city main on Market St., respectively), were three 4-in. standpipes with hose attachments on each floor, and terminating in roof hydrants with double hose connections on each. Hose was also kept attached to these roof hydrants under cover of hose houses prominently marked as such. This risk which contained property of great value, estimated at, approximately, $1,100,000 was only slightly damaged, having been saved by means of the fire shutters, a short parapet wall built at the request of this association, and more especially by the excellent service rendered by the roof hydrants under pump pressure.

The lessons taught by this fire are many of them too well known to need repetition (such as the defective construction of department stores in buildings not intended for the purpose, but altered from time to time to meet immediate requirements; the value of standard fire shutters; the value of automatic sprinklers, and their limitations, etc., etc.), but among the special lessons impressed upon us at this time is the grave danger of not protecting windows exposed by large area risks with standard fire shutters or wire-glass windows, for we believe had the Lippincott building been so equipped on its western wall, that building would not have burned. We also cannot speak too highly of the value of the roof hydrants on the establishment of Lit Bros. in connection with a pump located in a fire-proof room under the sidewalk, and of the good judgment of the fire department in permitting that pump to be used although drawing water from the city mains, and probably diminishing the already inadequate supply available for the regular fire engines of the department. This result was obtained, we believe, by the suggestion of this association that the fire department be made thoroughly familiar with the pump and hydrant system in that risk, at the time of its installation but a few months before. In fact, the fire department, when arriving on the scene, made use of the private equipment in preference to hauling up their own hose, and during the fire six streams were applied from these roof hydrants under excellent pressure, and were largely responsible for the saving of the establishment of Lit Bros., and incidentally also, we believe, the neighboring establishment of Strawbridge & Clothier.

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[1] Prof. J. B. Johnson, in his "Materials of Construction," has plotted these results of M. Considère in the shape of a stress-strain diagram, and shown that the area of the latter for soft iron wire is about 30% greater under shock than under a steady load.

[2] This difference of fracture was also noted by Andrews on wrought-iron car axles under impact.

[3] I. e., in tests of La Chatelier, and others, at the Berlin Testing Laboratory and Cornell University.

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ADVERTISING RATES: 20 *cents a line. Want notices, special rates, see page XXI. Changes in standing advertisements must be received by Monday morning; new advertisements, Tuesday morning; transient advertisements by Wednesday morning.*

We print in this issue, practically in full, the report of the committee appointed last spring by Governor Roosevelt to advise the State of New York what policy it should pursue with reference to its canals. This committee was made up of engineers and business men, qualified by their ability, experience and reputation to act as experts in the investigation of the questions submitted to them. Their conclusions, briefly stated, are, first, that to leave the canals in their present condition would be equivalent to their abandonment; second, that the proposal for a ship canal from the Lakes to the ocean would not result in the advantages that have been claimed, and is, besides, an enterprise for the United States and not the State of New York to consider; third, that the State ought to build a canal from Lake Erie to the Hudson River navigable for 1,000-ton barges, at an estimated cost of $60,000,000, in round figures.

In a later issue we shall discuss at some length the recommendations of the commission and the grounds on which they are based. For the present we lay the report before our readers with high commendation for its intelligent and dispassionate treatment of the difficult problem which was laid before the committee. It is a valuable contribution to engineering literature, and a treatise on economic transportation under present day conditions that can nowhere be duplicated.

Coincident with the appearance of this report appears the report of the commission which has been for over a year investigating the causes of the alleged decline of the commerce of the port of New York. It should be clearly understood that this much advertised "decline" is only relative; not absolute. The exports from this port in 1899 amounted to $450,000,000, and in 1898 to $437,000,000, both of these figures being larger than the total reached in any previous year. It is because New York has now only about 37% of the total United States export trade, instead of about 45%, as she had in the '70's; that this hue and cry concerning "the decline of New York's commerce" has been raised. It is fair to say that this reduction in the rate of growth—to call it by its right name—has been most marked in the exports of grain and flour.

The recommendations of the Commerce Commission are in brief that the $9,000,000 improvement of the Erie Canal be completed, and that provision be made for canal terminals and the reduction of terminal charges at New York and Buffalo, together with needed improvements of the port of New York in the way of docks, etc. Incidentally the New York Central & Hudson River R. R. is given a round scolding for acceding to the differential charge against New York, and canal competition is set forth as the proper punishment to fit its crime.

It will be seen that the Commerce Commission recommends only the completion of the $9,000,000 improvement to the Erie (at a cost assumed at $15,000,000), or a canal affording passage to boats of about 400 tons, while the canal committee recommends a $60,000,000 canal for 1,000-ton boats. There can be no question, however, that the latter recommendation should carry far more weight than the former, for it is made as a result of more thorough study, and by men much more competent to give expert opinion upon the question.

It is, in fact, by no means unlikely that the Commerce Commission's recommendation for canal improvement was founded on the same basis as the famous $9,000,000 "estimate" of 1895; not upon what was necessary to be done, but upon a guess at the maximum sum which the voters of the State could be induced to approve. New York has had quite sufficient experience with this sort of estimates. It may be taken as fairly well settled that either New York will embark on the larger enterprise, or else she will permit her canals to pass into "innocuous desuetude." Which course she will choose, it would take a wise prophet to foretell; but it will certainly take an educational campaign of extraordinary vigor to persuade the voters to approve a $60,000,000 canal project, after their unfortunate experience with the $9,000,000 project of 1895.

On another page of this issue a contributor presents an approximate computation of the comparative cost of electric current if generated by steam or if transmitted by high-potential electric currents over a distance of 40 miles. He shows that under ordinary conditions, as respects the price of coal and the cost of water power development, steam power is considerably the cheaper.

In view of the present activity in the development of water powers for electrical transmission, these figures are significant, and worth careful consideration. It is not laymen alone who are allowing themselves to be misled respecting the possibilities of long distance electrical transmissions. Not many weeks ago there came to this office a chief engineer of a large and powerful corporation with a proposition for the development and transmission of water power over a distance above 100 miles to a city where coal can be laid down for about $2 per ton.

The stock answer to the skeptic who expresses doubts as to the commercial feasibility of any such scheme is: "Electricity is only in its infancy you know, and a way will be found by which electric transmission will be possible, by the time the power is developed."

To this idea we must take decided exception. Electricity is not in its infancy by any means. It is as well developed at the present day as any other branch of mechanical engineering, and future progress and change are likely to proceed at a more moderate pace. The efficiency of modern electrical apparatus is remarkably high, so much so that there is only limited room for further improvement here. A large amount of hand work appears to be a permanent necessity in the construction of electrical machinery, and adds considerably to its cost. Reductions in this cost will probably be made in the future, but they are likely to come slowly. As for reduction of the cost of transmission by increasing the pressure, enough experience has now accumulated with high-potential electricity to indicate that there are pretty definite limitations to the use of high potentials, beyond which we cannot go without danger and risks that make its use more costly than the lower potentials. For these reasons investors in remote water powers should at least "look before they leap," and make sure that the conditions make possible the profitable development of these powers before they invest money in their purchase and improvement.

THE DISPOSAL OF CITY WASTES AND THE BARREN ISLAND GARBAGE REDUCTION WORKS.

The bill for the abolition of the garbage reduction works at Barren Island, now before the New York Legislature, adds interest to the illustrated description of that plant given elsewhere in this issue. It also renders timely a discussion of some of the problems involved in the disposal of city wastes and an outline of the steps leading up to the establishment of the Barren Island plant. This may well be followed by some remarks on the present crusade against the works named, which, by the way, constitute by far the largest garbage disposal plant in the world.

In judging of the success or failure of works for the disposal of the various sorts of city refuse, it should be remembered that comparatively few cities, the world over, have yet placed the disposal of the great aggregations of waste materials due to concentrated populations on anything like a scientific basis. These wastes, in order of sanitary importance, are sewage, garbage, street sweepings, stable manure, rags, tin cans, bottles, paper and a great variety of rubbish, including castaways of leather, wood, earthenware and metal. The proper disposal of sewage is of infinitely greater significance than any of the other materials named, but garbage may become a menace to health through fouling the air or soil during its decomposition, and tin cans and bottles are often so intimately associated with decomposable organic wastes, and so seldom cleansed before being thrown out, that they are liable to give rise to offensive odors.

Street sweepings are objectionable because they contain a considerable amount of organic matter, largely horse manure, and because if not properly collected and removed they give rise to street dust in dry weather and slime and mud in wet, damaging the eyes and respiratory organs of pedestrians, penetrating houses and places of business with like effect and increasing the chances of complications from damp feet. Besides these dangers, certain diseases, notably pulmonary tuberculosis, or consumption, are disseminated by street dust, and will continue to be until a higher standard of personal decency and public sanitation put a stop to the filthy and dangerous habit of expectoration onto the streets and the floors of cars, halls and other public places. The dangers from this source are far greater than is popularly understood, or it would never be tolerated to its present extent, especially from consumptives, most of whom are allowed to and do spread disease-germs broadcast so long as they are able to go about. From what has been said regarding street dirt, it may be inferred that prompt and proper means for its collection and removal are in some respects more of a problem than its final disposition; for unless mixed with garbage or other readily decomposable matter comparatively little sanitary trouble is experienced with street-sweeping dumps, whether on land or sea. If such dumps are near thickly inhabited areas, or if low lands filled with them are used too soon for building purposes, difficulty or danger may develop.

Stable manure is generally in such demand for fertilizing purposes that its disposal is principally a matter of sanitary supervision by municipal authorities. Old rags are a menace to health as a vehicle for the spread of certain diseases, but only a fractional percentage of the population of a city is affected by them, principally rag-pickers and sorters and the operators in such factories as utilize them without disinfection. Other classes of light rubbish are even less dangerous, providing they are not contaminated by being mixed with more objectionable wastes.

Ashes, when unmixed with other refuse, are among the cleanest of all city wastes, and in general the most sanitary if kept from the winds. Unfortunately, most cities allow all sorts of more

or less decomposed organic matter to be mixed with otherwise clean ashes, but there is now a strong tendency to prohibit this practice.

Sewage, as has been stated, is the most dangerous of city wastes, which, together with the ease of its removal by the water-carriage system, accounts for the fact that its collection has been brought to a higher state of perfection and is far more universal than that of other city wastes, although its final disposal is generally left to nature. Little more will be said regarding sewage, since garbage and associated wastes are our especial topic at present.

Garbage cannot, like sewage, be carried away from houses by a concealed underground piping system. Instead, it accumulates in (unnecessarily) malodorous boxes, barrels or cans, to be scattered by predatory dogs, cats and rats, until laboriously removed by the city scavenger. This removal is only the beginning of the end of trouble, for, whether deposited on land or water, within any reasonable distance of a city, nuisance is sure to follow. On land, putrefaction, with resultant foul odors, ensues, and on water the lighter portions, including much organic matter, floats ashore, and fouls beaches which should be clean and popular resorts for health and pleasure.

Burial in the earth disposes of garbage in a perfectly sanitary manner; but an army of men and a whole country-side of land is needed for the purpose where large cities are involved, and land is either too dear or the distance so great as to make the cost of transportation prohibitive. These various causes have each and all operated to compel some of the larger cities to attempt some improved means of garbage disposal, and the movement has been expedited by the belief that incidentally a profit could be made, or at least part of the expense regained, from the grease and fertilizing material in the garbage. Most of the smaller cities, however, have attempted little or nothing in the way of systematic garbage disposal; and this, together with the unsatisfactory achievements in many instances where such attempts have been made, more than justifies the assertion that this branch of city wastes disposal is still on an unscientific basis in most cities. The case with sewage is still worse, for of the 15 largest cities in the United States in 1890 (all with over 182,000 population) Chicago and Baltimore are the only ones that have not now or have not previously had, works in operation for the treatment of their garbage. Chicago has tried repeatedly to let a contract for that purpose, and Baltimore, like New Orleans, is still without a sanitary sewerage system. None of these cities (save small portions of Greater New York) have yet attempted to purify their sewage, although Boston, Chicago and Cleveland have provided or are providing for improved means of disposal by dilution.

Going down the list of cities comparatively few are found that have abandoned relatively primitive means of disposing of their sewage and garbage, while where attempts have been made, by cities great or small, the results often tend to bear out the statement made at the start, that few cities have yet placed the disposal of their wastes on a scientific basis. This is even more true when other classes of refuse are considered, as will be apparent on reflection.

This deplorable state of affairs is due more to neglect and indifference than lack of knowledge or ability to solve the problems of waste disposal. The questions at issue fall within the domain of engineering, chemistry, biology, finance, and, although an ante-climax, the junk trade.

Leaving sewage out of account, New York city has probably given more study, both in point of amount and intelligence, to the subject of waste disposal than any other municipality on this continent, and, with a few possible exceptions, than any abroad. As the study has progressed, one principle after another has been established, and a few put in operation, until some notable achievements have been made and other similar ones only await the necessary authority and money to be carried out.

One of the first forward steps resulted from the report of Mayor Grant's Advisory Committee, in 1891, composed of Morris K. Jesup, Thatcher M. Adams, Prof. Chas. F. Chandler, D. H. King, Jr., and Gen. Francis V. Greene, M. Am. Soc. C. E. This report was devoted to the collection rather than the disposal of wastes and was chiefly valuable for pointing out the need for and possibilities of business rather than political methods to that end. It did lay down some fundamental principles regarding the various classes of wastes which deserve to be recorded here: (1) Street sweepings, at least in New York, contain too little fertilizing material to pay the cost of transporting them where they could be utilized for that purpose, and in fact not enough organic matter to prevent their use for filling in low ground, under proper conditions. (2) Coal ashes, when free from garbage, make even better filling material. (3) Garbage, when kept separate from ashes and street sweepings is valuable for fertilizing purposes or feeding swine (strong dissent must here be expressed to feeding garbage, in its usual advanced stages of decomposition, to any animals). (4) The three forms of wastes, if mixed, lose their pecuniary value, unless for filling behind bulkheads, piers, or on land remote from dwellings.

Later, in 1892, the investigations of this subject were continued with especial reference to final disposal, by Messrs. Theo. F. Myers, and Edw. P. Barker, of the Board of Estimate and Apportionment. They also took a firm stand in favor of the separation of ashes and garbage, and against any more dumping at sea; they thought cremation the coming system of disposal, evidently not taking the reduction system into consideration, but as it might be years before a system of cremation adapted to the needs of New York became available, they recommended that the wastes of the city be used to fill in around and increase the borders of Riker's Island. This course they considered feasible because assured that garbage and ashes might be dumped under water without injury, and that with recent advances in disinfectants and assured advances "this year" the health department was willing to assume responsibility for dumping above water. The adoption of this recommendation, about a year later, resulted in the Riker's Island nuisance of the summer of 1894, and in legislative action prohibiting the dumping of mixed refuse (that containing garbage) at Riker's Island. This experiment served two very useful purposes: (1) It emphasized anew the necessity of separating ashes from garbage, if the former were to be used for filling; and (2) it resulted in the appointment of Mayor Gilroy's Advisory Committee, which reported in November, 1894. This committee was composed of Franklin Edson, Lieut.-Commander Daniel Delehanty, U. S. N., Chas. G. Wilson, President of the Board of Health, and Wm. S. Andrews, Commissioner of Street Cleaning. It declared "that light, floatable and offensive material, such as decayed vegetable and animal matter * * * * could not be deposited at sea at a less distance than 200 miles from the harbor without contaminating the Long Island beaches." In response to a request for schemes for final disposal 70 different plans were submitted. Of these 49 were considered practicable and were classified as follows: 18 proposed to burn all the wastes; 6, to burn garbage only; 2 others had an automatic separation, with utilization of the valuable portion and burning the rest; 7 suggested reduction; 4, self-dumping boats, evidently with disposal at sea; and finally there were 12 projects classed as miscellaneous. The 49 promoters of hopeful plans were invited to appear before the committee and explain their ideas. The committee also visited twelve disposal plants in actual operation, both cremation and reduction. It was not wholly satisfied with cremation, but reported that the reduction processes were "thoroughly sanitary and although not free from offense can be, doubtless, made so." The two main causes for complaint at the reduction works were odors from the green garbage on its delivery at the works and "the foul effluent water from the condenser." As a remedy it was suggested that the garbage be deodorized and the effluent water be given some chemical treatment. It is interesting to note that these causes of complaint have been also among the ones at Barren Island; that besides using deodorants the vapors from the factory at Barren Island, are now passed through a scrubber, and that the effluent water is evaporated and the resultant "stick" utilized with the other fertilizing material.

The chief objection to reduction, the committee said, was that its adoption would necessitate the separation of ashes and garbage, but such a course it considered reasonable. Mayor Gilroy's Advisory Committee finally recommended the adoption of the reduction process for the garbage; and the filling in of Riker's Island, with ashes and street sweepings, conveyed by self-propelled boats. It held the idea that street sweepings had or might have a market value, for it suggested their sale whenever they proved to be worth more as fertilizer than for filling.

During the years 1895-6-7, the late Col. Geo. E. Waring, Jr., was Street Cleaning Commissioner. He entered upon all the work of the department with a degree of energy and intelligence that will never be forgotten in New York, and which has been the inspiration of many other cities. After putting the work of sweeping and carting on a business basis he turned his attention to final disposal. As early as March 26, 1895, he had obtained 26 informal bids for the reception and disposal of garbage. The average price named for burning was 90 cts., and for reduction, 55 cts. per ton, but "only about half of the 26 bidders were believed by the Department to be sufficiently experienced and responsible to make offers from them acceptable to the city."

During the greater part of the year 1895, and on into 1896, Colonel Waring had a staff of able assistants studying the waste disposal problem in all its phases. Men were stationed at different reduction plants for days and weeks, where they were afforded every facility for studying the systems in use, as to methods, economy and sanitary results. The grease, fertilizer, waste, rag, paper and junk trades were studied in detail and experiments in sorting and selling wastes were tried. Between about Dec. 1, 1895, and May 1, 1896, bids were received four times for the disposal of part or all of the wastes collected by the Department. Twice the bids were rejected because unsatisfactory to Colonel Waring, and once the particular bid accepted by him was not approved by the Board of Estimate and Apportionment. All these bids served to clear the air and to indicate that the garbage might best receive separate treatment. The final bids, April 27, 1896, were in response to three propositions, the material in each case to be delivered at the dumps, onto scows, by the city, the prices to be lump sums per annum. The plans and estimated yearly quantities were as follows: (1) Ashes, street sweepings garbage and other refuse and rubbish, 2,750,000 cu. yds. per year; (2) garbage alone, 500 tons daily, or 156,500 per year; (3) all wastes except garbage, 2,500,000 cu. yds. per year.

No bids were received under (3). For garbage alone the bids were: Merz Universal Extractor & Construction Co., $144,000; New York Sanitary Utilization Co., $89,990; Edw. Duffy, $50,000. The latter, or lowest bid, was rejected because the process, as then used at Pittsburg, was not considered satisfactory, and the next to the lowest bid accepted. Both bids for all wastes except ashes were rejected because on reconsideration it was estimated that the material actually amounted to only 1,928,000 cu. yds. a year, and that it could be put in place at Riker's Island for $136,888 per year, at the some time making 50 to 60 acres of land. A further reason for rejecting these bids was an informal offer of $245,000 a year from Mr. Herbert Tate "for the privilege of picking over the rubbish of the city, aside from garbage, ashes and street sweepings, so far as it is practicable to make the separation." This offer was based on actual experiments by Mr. Tate, under Col. Waring's direction. Under the award made for garbage disposal, as just noted, and a subsequent award prior to consolidation, on the part of the city of Brooklyn, the garbage reduction works at Barren Island were constructed. The award in New York made necessary the separation of garbage from other refuse, so far as practicable, and the separate system of house cans and cart collection has been maintained with fair success for several years past. In addition a third separation was gradually introduced, and in 1898 and 1899 garbage, ashes and other refuse have each

been stored at houses and carted away separately, in Manhattan and the Bronx (old New York). Owing to complications which cannot be noted here, for lack of space, very little filling has been done at Riker's Island, and only one small plant for sorting refuse for salable material and burning the balance has yet been put in operation. This lack of sorting plants and furnaces has made it necessary to dump the rubbish carts on the same scows as receive the street sweepings. Both schemes, however, are still considered practicable, and it is hoped that they may be put in operation in the near future. The filling, of course, need not be at Riker's Island, if there is a greater demand for the material elsewhere; while, on the other hand, the ashes and street sweepings may still continue to be sent to sea, if prices for doing this are more favorable than for filling in. The freedom of choice between filling and dumping would be greatly increased if all the light refuse, such as paper, pasteboard and wooden boxes, barrels, old furniture, shavings and other matter were not again mixed at the dumps, after separate collection, a practice which the street cleaning department supposed would be rendered unnecessary long ago.

Any course of action that means or makes easy the wholesale return to the old method of indiscriminate mixing of the wastes of the city should be given the most careful consideration before it is adopted; for notwithstanding what may be said in favor of the "one collection" system, it must be remembered that the present plan of separation has been evolved step by step by a succession of committees, street cleaning commissioners and other investigators, beginning with the Advisory Committee of 1891, and, therefore, should not be lightly cast aside. Separation must be practiced where the reduction system is employed, and there is much to be said in its favor when garbage is cremated. In fact, now that separation is an accomplished fact, it would be the height of folly to depart from it even were cremation to be adopted, especially in view of the almost certain long hauls, or tows to the furnaces.

Little space remains to consider the proposed abolition of the Barren Island reduction works by legislative action. A bill to that effect was passed by the last legislature, but very justly vetoed by Governor Roosevelt, because it was too summary, simply closing down the works which dispose of the garbage of three million people without a moment's opportunity to provide a substitute. Another bill, only a little less summary, was introduced at Albany at the very opening of the present session of the legislature. After a careful study of all the steps leading up to the establishment of the reduction works at Barren Island, and after an examination of the works themselves, supplemented by inspections of both reduction and cremation works in many other cities, we have no hesitation in saying that no good and sufficient reason for shutting down the Barren Island garbage reduction works has yet come to our attention. Certainly no substitute has been proposed which guarantees disposal of the garbage of Greater New York in any more sanitary manner, nor for anything like so low a price as now prevails.

The New York contract expires Aug. 1, 1901, and the Brooklyn contract a few months later. In two years Greater New York should be in a far better position than five years earlier to make contracts for garbage disposal, for it can then profit by its own experience, and that of other cities as well, and both the present contractors and everyone else in the field will have learned some valuable lessons in the treatment of garbage, both sanitary and economic.

So far as we have learned, the complaints against Barren Island have been made by a mere handful of people, compared with the population served by the works. While this in itself is no justification of a nuisance, if one exists or has existed, yet it suggests the need of great caution lest a great injustice be done to the many on account of possibly ill-founded complaints of a few, or of evils that might be easily remedied. The question, at the worst, is not one of life or death, like the pollution of a public water supply. Moreover, the reduction works were especially designed to prevent the littering of beaches and the general fouling of waters and shores with unsightly and oftentimes offensive garbage from the old sea dumps. It would be small encouragement for a city to go to great pains to alleviate or prevent a nuisance if the results of years of effort to that end were liable to be summarily legislated out of existence. In short, a state legislature is not a proper body to pass upon alleged cases of nuisance. It may enact into law certain general prohibitions regarding the pollution of public water supplies or other nuisances, but if it once undertakes to pass upon specific cases, where is it to stop? State and local boards of health are established to look after individual nuisances, and if they fail, public attention should be directed against them or those who appoint them, instead of appealing to the legislative body, which can by no possibility perform administrative as well as legislative functions with success.

The country at large is, or should be, deeply interested in the success of the Barren Island plant, for it is an important and successful part of one of the most notable attempts ever made to dispose of a great city's wastes in a scientific manner, and such attempts have been all too few. The scheme is so important that it may, in conclusion, be restated: Instead of indiscriminate mixing of a city's wastes without regard to their sanitary qualities or commercial value, they are to be separated along those two lines and disposed of in the most innocuous and economical manner. Ashes and street sweepings may be used for filling or dumped at sea, according to local conditions, all floatable and readily decomposable matter being rigidly excluded. Garbage is to be made into grease and fertilizing material, or on the expiration of the present contracts, disposed of in any more economical and sanitary manner that may be presented. Paper, rags, and other light refuse, kept free from all decomposable material, are to be sorted over for salable products, and the residue is to be burned, the rejected matter forming its own fuel, furnishing all needed power for operating the plant and perhaps a surplus for sale. The plants for disposing of this latter class of material should be sufficiently numerous to reduce the cost of haulage. Thus far, the only parts of this scheme in full operation are garbage reduction, the full measure of separation in old New York and the separation of garbage from ashes and other refuse in Brooklyn. It is to be feared that the summary closing down of the Barren Island works would throw all the garbage back onto the city for some time, leaving no alternative but dumping far out to sea at enormous expense and nullifying the advantages of separation, if not putting a stop to the practice before there has been an opportunity to fully test its advantages.

LETTERS TO THE EDITOR.

Country Houses of Portland Cement Concrete.

Sir: In reply to the query of J. A. (Elk Rapids, Mich.) in your issue of Jan. 11, it may be stated that many houses of concrete (or "grout houses" as they are locally called) are to be found in the valley of the North Platte River in Nebraska and Wyoming. Many are made of concrete made in the vicinity. I might name John Powers and Mr. Merchant, of Sunflower, Neb.; P. and F. Rauch, Pratt, Wyo., and Mr. Acheson, postmaster of Gray Rock, Wyo., as being able to furnish reliable figures which might prove of value to your correspondent.

Yours very truly,

Sterling, Colo., Jan. 22, 1900. F. T. Darrow.

The Plural of "Datum."

Sir: In your issue of Jan. 25 you have incidentally called attention to the erroneous use of the word "data" in the singular number. It seems to me, in view of the unfortunate prevalence of such use of this word, and of a few similar words, that your extensively read paper might with good effect point out these grammatical errors more conspicuously, so that those of your readers who unwittingly, and perhaps unconsciously, have fallen into a wrong habit, may have their attention called to the "slip."

Those who have studied Latin and Greek are not apt to make these errors, but engineers are no longer compelled to study the old classics, and, I think, fortunately, can now devote more time to the study of modern knowledge instead. No knowledge in this country can, however, be superior to that of the proper use of the English language, of its words and expressions, but such knowledge may be as well obtained directly as through the circuitous route of first studying other languages. I would respectfully suggest that those of your readers who feel guilty should "paste the following in their hat:"

This datum is	These data are .....
This stratum is	These strata are .....
This memorandum is ..	These memoranda are .....
This effluvium is	These effluvia are .....
This phenomenon is	These phenomena are .....

Yours truly, Rudolph H...

100 William St., New York, Jan. 25, 1900.

Broken Stone vs. Gravel Concrete.

Sir: Your issue of Nov. 9, 1899, containing a communication from me concerning the relative strength of concrete made of broken stone and of gravel, in which I asked for the results of experiments along this line, I assumed that replies would appear in your columns. One reply appeared in your issue of Dec. 14, 1899, and I have received two letters—one from the far east and one from the west—giving brief accounts of experiments with the two kinds of concrete. Neither writer wishes to be quoted.

One of these correspondents as a result of experiments "found a difference in tensile strength of from 80 to 100% between a rather soft stone with rough surfaces and a hard, flinty stone with smooth surfaces." The proportions by weight and the mode of manufacture were the same in both cases. He also found that "concrete made with stone aggregate was stronger than that made with cement and sand." This correspondent from his experiments and also from practical observations concludes that gravel concrete is inferior to broken-stone concrete.

The other correspondent says he has "made at least several hundred experiments on the tensile strength of concrete" and is "sure that under the same conditions concrete gravel is stronger than that with broken stone." He then goes on to explain that the broken stone had 48% of voids (the smaller fragments having been screened out), while the gravel had only 33%. This correspondent by the term "under the same conditions" (see quotation above), evidently means "with the same proportions," for screened broken stone with 48% of voids is certainly not "under the same conditions" as gravel with only 33% of voids. Properly translated, this correspondent's conclusion means that gravel with 33% of voids makes a stronger concrete than broken stone having 48% of voids, which conclusion is probably correct; but this gives no indication as to the relative strength of concrete made of unscreened broken stone in comparison to that made with gravel.

Ira O. Baker.

University of Illinois, Campaign, Jan. 24, 1900.

The Manufacture of the Bonzano Rail Joint.

Sir: Now that the modern steel rails and rail joints are under discussion, I would like to call attention to an important matter that was not referred to in your former article on the Bonzano Rail Joint, Eng. News, Oct. 20, 1898. The angle splice bars are rolled, as you state, the same as in ordinary practice, with the flange about 3 ins. wider than usual. These bars, after cooling, are cut to length and punched. This, as in all other cases of punching cold steel, injures the metal surrounding the punched hole by compressing and hardening it, and the metal may also be slightly bulged at the bolt holes (as is sometimes the case with other forms of splice-bars), giving local contact points with underside of head of rail. These troubles are well known, but they are entirely removed in the Bonzano joint by very simple operations in its manufacture, in following manner:

The bars are heated to a low temperature and placed in the forming dies; pressure is applied and the flange is bent down to its finished shape; the metal in the body of the bar is forced tightly into the dies, which removes all bulging, and the top bearing surface is brought to a straight line giving perfect bearing surface. This heating also removes the injurious effects of punching by annealing; the metal surrounding the punched holes is restored to about same condition as that in other parts of the bar. In fact, this method of annealing steel after punching has been advocated as a substitute for reaming punched holes, and tests of steel so treated have given satisfactory results.

These matters, small as they may appear, are of vital importance, and by following the method of manufacture described much better splice bars are obtained than would be the case if the punching was the last operation.

In England much higher carbon steel is used in splice bars than in this country, but their bars are punched hot and the metal surrounding the hole is not injured. The same bars would not give satisfactory results if punched cold and put in track without annealing. But with the Bonzano joint a high carbon steel can be used with safety, if it should be found desirable, by following the method of manufacture described above. Wm. R. Webster.

413 Walnut St., Philadelphia, Pa., Jan. 26, 1900.

The Design of Columns for Sheds Exposed to Wind and of Concrete Bases for Columns.

Sir: I present herewith a computation for concrete bases for columns, which you asked for in your issue of Oct. 19, 1899, and a correct calculation of structures like freight and passenger sheds exposed to wind or not, such as were described in your issue of Oct. 5, 1899. I must confess I was much astonished to see in your esteemed paper a totally incorrect computation for structures of this kind. It is more than 20 years since such structures have been calculated as arches with two hinges, or arches firmly fixed, and since they were first used in the Paris Exhibition of 1878. A structure of this kind will always deflect, as shown at a (Fig. 1), and not as shown at b (Fig. 1), as Mr. Pemoff claims. The simple formula which I deduce has never been published. It is very simple to use and saves in all cases about 20% of material.

Fig. 1.

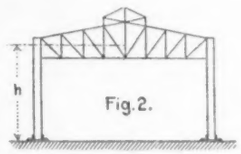


Fig. 2.

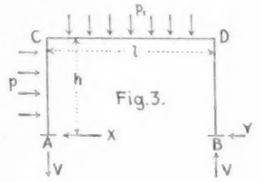


Fig. 3.

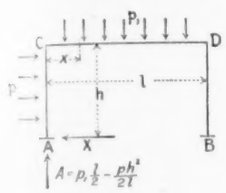


Fig. 5.

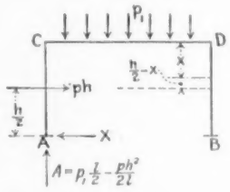


Fig. 6.

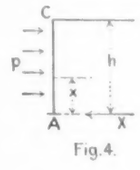


Fig. 4.

ENG. NEWS.

DESIGNING OF COLUMNS FOR FREIGHT AND PASSENGER SHEDS EXPOSED TO THE WIND.

The Designing of Columns for Freight and Passenger Sheds Exposed to Wind.—Structures like Fig. 2, exposed to wind or not, are always in good practice calculated as arches with two hinges. To simplify the calculation, we will consider this structure as a curved beam, of the skeleton form shown in Fig. 3, and will assume that the moment of inertia of the principal C D will be constant and equal d, and that the moment of inertia of the stanchions will be d_1. We will call the wind-pressure per inch run of the stanchions p, and the load per inch run of the principal p_1.

The wind-pressure will first produce at A and B vertical reactions V, which we obtain from the equation:

$$p \cdot h \cdot \frac{h}{2} = V \cdot l, \text{ or } V = \frac{p\,h^2}{2\,l}. \qquad (1)$$

Hence, the vertical reactions at A and B will be:

$$A = \frac{p_1\,l}{2} - \frac{p\,h^2}{2\,l}; \quad B = \frac{p_1\,l}{2} + \frac{p\,h^2}{2\,l}. \qquad (2)$$

The horizontal reactions at A and B, we will call X and Y, and, evidently

$$X + Y = p \cdot h. \qquad (3)$$

The moment about any point of the stanchion A C (see Fig. 4) is

$$M_1 = X\,x - \frac{p\,x^2}{2}. \qquad (4)$$

The moment about any point of the principal C D is

$$M_2 = X \cdot h - p\,h \cdot \frac{h}{2} + \left\{p_1\,\frac{l}{2} - \frac{p\,h^2}{2\,l}\right\} x + \frac{p_1 x^2}{2}. \qquad (5)$$

The moment about any point of the stanchion B B (Fig. 6) is

$$M_3 = X\left(h - x\right) - p\,h \cdot \left(\frac{h}{2} - x\right) + \left\{p_1\,\frac{l}{2} - \frac{p\,h^2}{2\,l}\right\} l - p_1\,l \cdot \frac{l}{2},$$

or

$$M_3 = X\,(h - x) - p\,h^2 + p\,h\,x. \qquad (6)$$

For the calculation of the statically indeterminate value X, we have only to consider that the distance A B must remain constant, which condition is contained in the equation

$$\frac{d\,L}{d\,x} = 0; \qquad (7)$$

that is, the differential coefficient of the deformation labor taken with regard to X

$$\left\{\frac{d\,L}{d\,x} \text{ represents the movement of A, which is here nill}\right\},$$

must be zero.

The expression for the deformation labor of a curved beam is given by

$$L = \int_A^B \frac{N^2\,d\,s}{2\,E\,Y} + \int_A^B \frac{M^2\,d\,s}{2\,E\,Y}. \qquad (8)$$

N, the normal force on any section, may be neglected here, so that there remains

$$L = \int_A^B \frac{M^2\,d\,s}{2\,E\,Y},$$

or

$$\frac{d\,L}{d\,x} = \int_A^B \frac{M}{E\,Y}\,\frac{d\,M}{d\,x}\,d\,s. \qquad (9)$$

For the part A C, we have from (4)

$$\frac{d\,M_1}{d\,x} = x; \text{ hence } \frac{d\,L_1}{d\,x} = \int_0^h \frac{X\,x - \frac{p\,x^2}{2}}{E\,Y_1}\,x\,d\,x.$$

and

$$\frac{d\,L_1}{d\,X} = \frac{1}{E\,Y_1}\left\{X\,\frac{h^3}{3} - \frac{p\,h^4}{8}\right\}. \qquad (10)$$

For the part C D, we obtain from (5)

$$\frac{d\,M_2}{d\,x} = h, \text{ and } \frac{d\,L_2}{d\,x} = \int_0^l \left\{X\,h - \frac{p\,h^2}{2} + \left\{p_1\,\frac{l}{2} - \frac{p\,h^2}{2\,l}\right\} x + \frac{p_1\,x^2}{2}\right\} \frac{h}{E\,Y}\,d\,x, \text{ which integrated gives } \frac{d\,L_2}{d\,X} = \frac{1}{E\,Y}$$

$$\left\{X\,h^2\,l - \frac{p\,h^3\,l}{2} + p_1\,\frac{l^2\,h}{4} - \frac{p\,h^3\,l}{4} - \frac{p_1\,l^3\,h}{6}\right\},$$

or

$$\frac{d\,L_2}{d\,X} = \frac{1}{E\,Y}\left\{X\,h^2\,l - \tfrac{3}{4}\,p\,h^2\,l + \frac{p_1\,l^2\,h}{12}\right\}; \qquad (11)$$

for the part D B

$$\frac{d\,M_3}{d\,X} = h - x, \quad \frac{d\,L_3}{d\,X} = \frac{1}{E\,Y_1}$$

$$\int_0^h \left\{X\,(h-x)^2 - p\,h^2\,(h-x) + p\,h\,(h\,x - x^2)\right\} d\,x,$$

or

$$\frac{d\,L_3}{d\,X} = \frac{1}{E\,Y_1}\left\{X\,\frac{h^3}{3} - \frac{p\,h^4}{2} + \frac{p\,h^4}{6}\right\} = \frac{1}{E\,Y_1}\left\{\frac{X\,h^3}{3} - \frac{p\,h^4}{3}\right\}. \qquad (12)$$

$$\frac{d\,L_1}{d\,X} + \frac{d\,L_2}{d\,X} + \frac{d\,L_3}{d\,X} = \frac{d\,L}{d\,X},$$

which equals 0, as was stated before. We obtain by summation of (10), (11) and (12), and after reduction, the simple formula for the horizontal thrust at A:

$$X = \frac{1}{h} \cdot \frac{\tfrac{3}{4}\,p\,h^2\left\{1 + \frac{11}{18}\,\frac{d}{d_1}\,\frac{h}{l}\right\} - \frac{p_1\,l^2}{12}}{1 + \frac{2}{5}\,\frac{h}{l}\,\frac{Y}{Y_1}}. \qquad (13)$$

If all the dimensions are in inches, p and p_1 in lbs., X is obtained in pounds; d and d_1 are not known. For the first calculation we may assume that X is approximately equal to 0.60 p h, which substituted in the equations (4), (5), (6), gives us the moments in the stanchions and in the principal from which we can obtain an approximate value of d and d_1; with these values of d and d_1 we can substitute in formula (13) to obtain a more accurate value of X, and, afterwards, better values for the moments, and finally the right dimensions for d and d_1. The stanchions become heavier because of the moments produced by wind-pressure, and the thrust X, but the excess of weight in the stanchions is more than annulled by the great saving of weight in the principals.

On the Calculation of Column Bases.—The distribution of forces in a foundation block is statically indeterminate. To obtain any practical value, we are obliged to make certain assumptions. We will assume:

(1) That the pressure of the granite on the concrete and of the concrete on the earth is equally distributed. If w and w_1 are the respective pressures per square inch, we can write, neglecting the weight of the concrete:

$$P = w \cdot C^2, \qquad (1)$$

and

$$P = w_1 \cdot A^2. \qquad (2)$$

(2) That the concrete deflects like a beam symmetrically about m n.

In that case, the calculation of the concrete block is the same as that of a beam, affected by an equally distributed load acting upwards in its whole length and by another equally distributed load acting downwards, but only on the breadth C.

$$M_x = \frac{A \cdot w_1}{2} \cdot \left\{\frac{a-b}{2} + x\right\}^2 - \frac{C\,w\,x^2}{2}. \qquad (3)$$

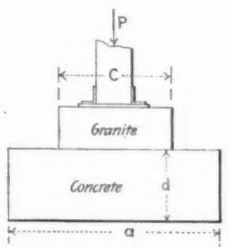


Fig. 1.

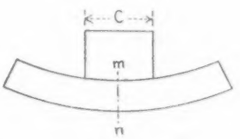


Fig. 3.

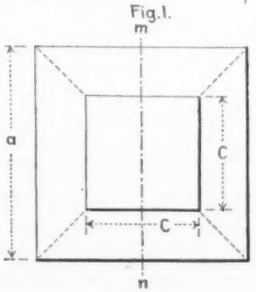


Fig. 2.

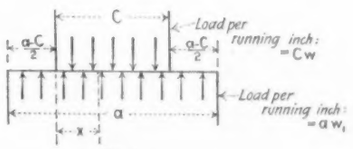


Fig. 4.

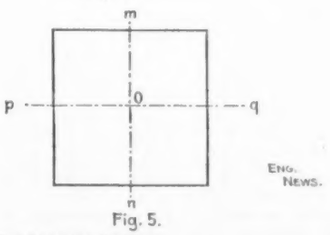


Fig. 5.

ENG. NEWS.

CALCULATION OF COLUMN BASES.

The maximum moment is evidently at $x = \frac{C}{2}$, and

$$M_{max} = \frac{P}{8}\,(a - C), \qquad (4)$$

[considering (1) and (2)], and must equal $S\,\frac{a\,\delta^2}{6}$, when S equals safe working stress per square inch; hence

$$\delta^2 = \tfrac{3}{4}\,P\,\frac{a - C}{a\,S}. \qquad (5)$$

If we assume a deflection symmetrical about a diagonal of the square, we obtain by a similar calculation

$$\delta'^3 = \frac{P}{2}\,\frac{a-C}{a\,S},$$

which is a smaller value.

It could be objected in regard to the above solution, that the deflection should be symmetrical about a vertical axis, going through the center of the square. To partially meet this we may assume, that half the load produces a deflection about m n, the other half about the axis p q, and from (5) we obtain the corresponding stress

$$S_1 = \tfrac{3}{4} \cdot \frac{P}{2}\,\frac{a-C}{a\,\delta_1^3}. \qquad (6)$$

In the center O, we have two stresses, S_1 acting 90° apart; the resulting stress, which must be the safe working stress, S is equal to $\sqrt{S_1^2 + S_1^2} = S_1\sqrt{2}$, that substituted in (6) gives

$$\delta' = \tfrac{3}{4}\,\frac{P}{2}\,\frac{a-C}{\frac{S}{\sqrt{2}}\,a} = \frac{\delta^3}{\sqrt{2}} \quad \text{or} \quad \delta = 0.84\,\delta. \qquad (7)$$

We see that for the latter assumption that the thickness is 16% less than the value given in (5).

Leopold Mensch.

11 Clifton St., Finsbury Square, London, E. C.,
Nov. 1, 1899.

WHAT SHALL NEW YORK DO WITH ITS CANALS?—REPORT OF THE GOVERNOR'S ADVISORY COMMITTEE.

The commission appointed by Governor Roosevelt in March last to investigate and decide upon the wisest policy for the State of New York to pursue toward its canals has completed its work, and, on Jan. 15, presented to the Governor its formal report. This is contained in an octavo volume of 231 pages, of which 43 pages are devoted to the report proper, and the remainder to a number of appendices in which some of the data made use of by the committee in reaching its conclusions are set forth at length. In a separate volume, the correspondence and opinions of various engineers and other experts upon the proper policy for New York to pursue with reference to its canals are given in full. The two volumes constitute a most valuable contribution to engineering literature, and should be obtained and preserved by all engineers interested in modern methods of economic transportation.

We print below the report of the Commission, condensing it only so much as limitations of space make necessary. Comment upon its recommendations we reserve to a future issue:

Honorable Theodore Roosevelt, Governor of New York:

Sir: The undersigned have carefully considered "the broad question of the proper policy which the State of New York should pursue in canal matters," as requested in your letter to us of March 8th, 1899,* and have reached the following conclusions:

First: That the canals connecting the Hudson River with Lakes Erie, Ontario and Champlain should not be abandoned, but should be maintained and enlarged; and that the Black River and the Cayuga and Seneca canals should be maintained as navigable feeders, but that they should not be enlarged at the present time.

Second: That the project of a ship canal to enable vessels to pass from the upper lakes to New York city (or beyond) without breaking bulk is a proper subject for consideration by the Federal Government, but not by the State of New York.

Third: That the project of 1895 for the enlargement of the Oswego and Champlain canals should be completed at a cost of $2,642,120.

That there are two projects for the enlargement of the Erie Canal which should be considered by the State of New York.

The first is to complete the project undertaken in 1895, with certain modifications, to wit: The deepening of the prism to 9 ft., throughout, and the lengthening of the locks on one tier so as to pass two boats, each 125 ft. in length, 17½ ft. in width and 8 ft. in draft, with a cargo capacity of about 450 tons each, and the lengthening of the locks on the other tier so as to pass a single boat of the same size; the use of pneumatic locks, or other mechanical lifts, at Cohoes and Lockport, and new locks at Newark and Little Falls, by which 21 locks will be eliminated; the construction of a new canal from near Clyde to near New London—about 81 miles in length—giving a wide waterway throughout the Seneca and Oneida Rivers and Oneida Lake, and avoiding the Montezuma marshes; the abolition of the two aqueducts across the Mohawk River, and the substitution of the river for the canal from Cohoes to Rexford Flats near Schenectady, and possibly as far as Little Falls; the construction of a new canal from the foot of the falls of the Mohawk, near Cohoes, to the Hudson River near the West Troy side cut. The estimated cost of this project is $21,161,645.

*Eng. News, March 16, 1899, p. 168.

The second project is to construct a canal along the same route as above named, but of sufficient size to carry boats 150 ft. in length, 25 ft. in width, and 10 ft. draft, with a cargo capacity of approximately 1,000 tons each. The prism of such canal to be not less than 12 ft. deep throughout, with not less than 11 ft. of water in the locks and over all structures, and the locks to be about 310 ft. long and 28 ft. wide, so as to pass two boats at one lockage. Such a canal will be capable of carrying a tonnage equal to the capacity of the St. Lawrence canals. The estimated cost of this project is $58,894,668.

In our judgment, arrived at after long consideration, and with some reluctance, the State should undertake the larger project on the ground that the smaller one is at best a temporary makeshift, and that the larger project will permanently secure the commercial supremacy of New York, and that this can be assured by no other means.

We believe our estimates of cost to be adequate for submitting this proposition to the voters at the election in November next, and in the meantime we advise that the Legislature make an appropriation of $20,000 to be immediately available for surveys, so that the detailed surveys, which are indispensable to the proper making of contracts, could be completed during the present year. If the proposition is approved by the people in 1900, the work can be completed, if properly managed, so as to be available for the season of 1905.

Fourth: That the money to pay for these improvements should be raised by the issue of 18-year bonds in the manner prescribed by the State Constitution, and that the interest and principal of these bonds should be paid out of taxes specifically levied, for benefits received in the counties bordering in whole or in part on the canals, the Hudson River and Lake Champlain; such taxes to be levied in proportion to the assessed valuation of the real and personal estate in such counties. These taxes will amount to about 10 cts. per $100 of assessed valuation annually during the period of 18 years.

Fifth: That the efficiency of the canals depends upon their management quite as much as upon their physical size, and that no money should be spent for further enlargement unless accompanied by measures which will accomplish the following results:

(a) The removal of all restrictions as to the amount of capital of companies engaged in transportation on the canals, and the encouragement of large transportation lines for handling canal business, in place of hampering them, as has hitherto been the case.

(b) The use of mechanical means of traction, either steam or electricity, in place of draft animals; and the use of mechanical power in place of hand power for operating the gates and valves and moving boats in locks.

(c) The organization of the force engaged on the public works of the State on a more permanent basis, so as to afford an attractive career to graduates of scientific institutions, with the assurance that their entry into the service, their tenure of office, and their promotion will depend solely on their fitness, as determined by proper and practical tests.

(d) A revision of the laws in regard to the letting of public contracts by the State, so as to make impossible a repetition of the unfortunate results of the $9,000,000 appropriation.

The reasons which have led us to these conclusions will be stated at length.

I.

Shall the Canals be Abandoned?

The inestimable benefits which have been derived from the Erie Canal in the past are not disputed by any one. To it, more than to any other cause, is due the phenomenal growth and commercial supremacy of the city and State of New York. It opened up the great West to settlement, and in turn attracted the products of the West to the low-grade line through the Appalachian chain, which exists only in the State of New York. The tolls on this water-way have more than repaid the cost of construction, maintenance and operation; in addition it has paid over $360,000,000 of freight money within the limits of the State, and the disbursement of this money along the line of the canal has built up the great interior cities from Buffalo to Albany, forming a continuous line of commercial centres, which has no counterpart in any other State. The growth of these cities in turn led to the construction of railroads paralleling the canal, and these by consolidation and scientific management have gradually reduced the cost of transportation during the last thirty years from an average of 2 cts. per ton mile to about 6 mills per ton mile.

Railway Competition of the Future.

No one disputes these evident facts; but the question which now confronts us is whether the railroads, with their large capital and scientific management, their durable roadbeds, powerful locomotives, larger cars, greater train loads, greater speed and more certainty of delivery, will be able now or in the early future to reduce the cost of transportation below what is possible on the canals. If they can do this, then it is obviously unwise and improper to expend any more public money upon a method of transportation which, however important in the past, would no longer be able to compete with other and improved methods. The determination of this question seems to us to lie at the very foundation of the canal problem, and we have therefore given it the utmost attention.

The claim for the railroads has been put forward at great length, and with ability, by the Engineering News, whose editorial articles on the subject are printed at length in the volume of "Minutes and Correspondence." In brief, they are to the effect that while the average railroad charges in recent years on the railroads of New York State have been about 6 mills per ton mile, yet a lower rate has prevailed on grain, lumber and similar articles, which have hitherto formed the bulk of the goods transported over the canal. The grain rates fixed in April, 1899, from Buffalo to New York were as follows, per bushel:

Wheat	3½ cts.
Rye	3½ "
Corn	3½ "
Oats	3½ "

The rate of 3½ cts. per bushel on wheat is about $1.17 per ton, or 2¼ mills per ton mile. It is further asserted in these articles that the Chesapeake & Ohio R. R. is carrying coal at a profit on a rate of 2¼ mills per ton mile; and that on the completion of locomotives now under construction by the New York Central and other railroads, designed to haul trains with from 2,000 to 2,400 tons of paying freight, the rate on such articles as grain, coal, ore, etc., by rail will be reduced to about 1 mill per ton mile. In other words, the argument in favor of the railways is that private enterprise and private capital will at an early date produce on the railroads as low a freight rate as can be produced on the canal by the expenditure of large sums of public money.

If this argument were correct, it is needless to say that no further money should be spent on the enlargement of the canals, but that they should remain in their present condition until plans could be carefully matured for the disposal of them. In our judgment, the argument is not correct. It would carry more weight if it were advanced or approved by practical railway managers; and we therefore sent the articles to the presidents of the New York Central R. R., of the Illinois Central R. R., and of the Pittsburg, Bessemer & Lake Erie R. R., the last of which was specially built under the most favorable circumstances for the express purpose of carrying ores and low-grade freight at a minimum cost from Conneaut on the lakes to Pittsburg. The reply of Mr. Fish is explicit that there is no probability of a rate of 1 mill per ton mile by rail in the near future. The reply of Mr. Callaway, while not so positive, leaves no doubt in the mind of the reader that the New York Central R. R. has no expectation of quoting any such rate. The reply of Mr. Reed states that during the past summer nearly a million tons of ore were hauled from Conneaut to Pittsburg at an actual cost for transportation alone of 1¼ mills per ton mile; the freight rate being 3.65 mills per ton mile. It is evident, therefore, that the views expressed in the Engineering News are not sustained by practical railway managers, responsible to their stockholders for the profitable management of their roads.

Railway Rates at Their Lowest Point.

The keeping of railway accounts is an intricate science; the system is not entirely uniform among different roads, and it is very difficult for any one to be able to state whether the carrying of grain at a rate equivalent to 2¼ or 2¼ mills per ton mile is done at a loss or a profit. It is more than probable that it has been done at a loss, the corporate wealth of the railroads enabling them to carry this loss, provided they were making a profit on other classes of goods, and they considered it desirable to hold the business until on the return of more prosperous times they would be able to secure a profitable rate. It is to be noticed that these extremely low rates have prevailed during the hard times from 1893 to 1898, during which many manufacturers thought it better to keep their factories in operation at a loss rather than to close them entirely. With the return of prosperity during the two years just ending the price of manufactured goods has increased from 30 to 60% (and more in some cases), and the railroads are already claiming that they have not shared in this prosperity, and that the time has come for an advance in railroad rates. Already the rate on grain across the State of New York has advanced from 3½ to 4 cents. per bushel. The price of rails, cars, locomotives and labor during the year 1900 will be very much in excess of what the railroads have been paying during the last few years, and this must inevitably be reflected in a considerable advance in freight rates. We believe, therefore, that the reduction in railroad rates, which has been almost constant for the last 30 years, has received a check, and that an increase may be looked for until the present prosperity shall be succeeded by depression, when it is probable that they will again decline; but it is very doubtful if they will go any lower, if as low, as the rates recently prevailing.

Relative Cost of Rail and Water Transportation.

In our judgment, water transportation is inherently cheaper than rail transportation. It varies slightly with the size of the vessel and the restriction of the waterway. On the ocean, where the waterway is entirely unrestricted and the size of the vessel is the maximum, it averages

about half a mill per ton mile;* on the lakes, where the vessels are not so large, and occasional restrictions are encountered on the waterway, it is about six-tenths of a mill per ton mile;† on the canals of New York where the boats are very small, the waterway greatly restricted, and obsolete methods are employed for handling the business, it is about 2 mills per ton mile. By the enlargement of the canal which we recommend, and the introduction of improved methods of management, we believe that the canal rate can be reduced to two-thirds of one mill per ton mile, or very nearly as low as the lake rates. All of these rates have varied in the past and will vary in the future to correspond with prosperity or depression in general business. But there is every reason to believe that they will maintain a corresponding ratio, the ocean, lake, and canal rates being from one-third to one-fourth of those by rail. The reductions which may be made hereafter in the railroad rate can be met by similar reductions in all three classes of the water rates, provided the same methods of skilled management are applied to all.

Moreover, the canals have been largely limited in the past to the lower grades of freight, and this is equally true of the transportation on the lakes. The canal has thus been in competition with the classes of freight which pay only between 2 and 3 mills per ton mile, and which the railroads will carry at a loss rather than lose the business, whereas, the railroads carry other classes of freight, some of which brings as high as 15 to 20 mills per ton mile, and the average freight, including the low grades, as we have seen, being about 6 mills. There is no reason why the canals, if enlarged and properly managed, should not compete for the higher grades of freight, which, at prices far below those charged by the railroad, would bring very profitable returns on the lakes and canal.

Development of Local Traffic on the Canals.

The local tonnage on the canals has for many years exceeded the through tonnage, just as it does on the railroads, although not to the same extent, and an enterprising transportation line, skilfully managed, could give an enormous development to this local traffic at profitable prices, and thus be in position, just as the railroads are, to carry through freight of low grade at cost or less in case of necessity. With the canal enlarged so as to carry boats of 1,000 tons each, and these boats assembled in fleets of four or six, with a total capacity of 4,000 or 6,000 tons, each fleet having detached mechanical motive power —the system of handling being analogous to that of a train composed of cars and a detached locomotive—it will be possible to send a boatload of freight of the highest or the lowest class through from any point on the lakes to any point on the Atlantic coast from Boston to Philadelphia. Experience will then prove whether it is more economical to send freight of different classes either all the way without breaking bulk, or to use the lake steamers to Buffalo and there transfer to the canal boat, which, of the size we have mentioned, can be safely taken to any point on the route between Buffalo and New York, or on the coast within the limits above named.

The system of using barges with detached motive power in the coast-wise traffic between New York and New England has been in operation for many years, and has reached enormous proportions. It has hitherto been confined to low-grade articles, such as coal and oil, whereas the high-grade package goods have gone by steamboat. It is possible that this division may continue to be economical, and in that event a trans-shipment at New York between the steamboat and the canal boat would be necessary. But we feel certain that if the water-way across the State of New York is enlarged so as to afford facilities for boats of 1,000 tons, and is so managed as to produce safety and certainty of delivery by responsible transportation lines, and at a rate far below that now prevailing on the railroads, a very large business will develop along such route in all classes of goods, and at enormous benefit to the State of New York, and particularly to the two great cities at its eastern and western ends.

Development of Water Transportation in Europe.

In considering this question of the relative advantages and cost of rail and water transportation, we have given much study to what is being done on the Continent of Europe; and one of our committee, Mr. F. S. Witherbee, has visited Europe for the purpose of gaining information on this point. His report is transmitted herewith, and a large number of documents, plans and photographs which he brought back have been deposited in the office of the State Engineer. It is found that on the continent of Europe so far from the canals being decadent during the last 30 years, they have been constantly enlarged and improved, enormous sums having been spent for this purpose, and the result has been an extraordinary increase in this class of transportation. It is well known that the railroad rates in Europe are much higher than in America. There are several reasons for this. In Europe there is none of the long-haul traffic, which is so much less expensive to carry, and accounts for so large a part of the lower ton mile rate in America. The management of the railroads is also less efficient. On the other hand, the management of the canals has been more efficient than with us. The result has been a far greater development in water traffic than in rail traffic during recent years in France, Belgium, Germany and Russia.

In France, since the war with Prussia, over 400 miles of new canals, and nearly 500 miles of new river navigation have been constructed, making nearly 7,000 miles of internal water-ways; the water traffic has increased from 1872 to 1897 by 140%, whereas the rail traffic has increased by but 75%. The little State of Belgium has expended since 1860 not less than $50,000,000 for enlarging its canals, and the water traffic increased from 1888 to 1896 by nearly 40%, and it is significant that the increase in the transportation of miscellaneous package commodities during the same period was 54%.

In Germany, the same process of betterment and extension of canals and water routes is continued. During the past year the new canal from Dortmund to Emden has been completed, and opened for traffic; this canal being especially noteworthy for the famous pneumatic lock at Henrichenburg, where vessels are lifted 45 ft. from one canal level to another at one operation. The modern type of canal boat in use on this canal is a barge of 1,000 tons carrying capacity, built of steel, about 230 ft. long, 30 ft. wide, and 7½ ft. draft, and costing only $5,000 each. The propulsion is entirely mechanical—either by steam or electricity. It is well known that the German government is planning a trunk route between the rivers Rhine and Elbe, and is strongly in favor of a large extension of its canal system; and that its plans would now be in process of being carried out but for the opposition of the agricultural interest, which fears the effects upon its own property of the reduction in rates which would certainly follow the execution of these plans.

In Russia, even greater efforts have been devoted to the development of the water routes on canals and rivers, the sum of $30,000,000 having been expended from 1891 to 1896 for this purpose, and in the same period the internal water traffic has increased by 70%. This traffic on Russian internal waters accommodates 1,500 steamers, and 60,000 canal boats, with crews numbering 300,000 men. Vessels 200 ft. long can traverse the whole length of the country from the Caspian Sea to St. Petersburg or Archangel (2,500 miles).

We do not think that these facts can be overlooked in the consideration of this problem. They show that in countries where the keenest competition exists not only within each country, but between each and its neighbor, effort is being made to gain an advantage, or, at least, keep on an equality, in the competition, by reducing the rates of transportation, and that to accomplish this large sums of public money are being spent to enlarge and improve the water routes; thus confirming the general proposition that under equal conditions of management the water route, even in a restricted way like a canal, is cheaper than the rail route.

Influence of Water Transportation on New York's Commerce.

New York has certain topographical advantages which it would be folly not to utilize. Through the valleys of the Hudson and the Mohawk and the comparatively low and level lands west of Oneida Lake, it is possible to construct a water route connecting the Great Lakes and the Atlantic coast, and no such water route can be constructed through any other State. It has no rival except in the St. Lawrence route. This State will inevitably have to compete with the routes by rail, and possibly by water, from the grain fields of the West to ports on the Gulf of Mexico. But in the transportation from the lakes to the Atlantic it has a great advantage, provided it is porperly utilized. If the water route is abandoned, then New York must take its chances in the railroad competition with Portland, Boston, Philadelphia, Baltimore, Newport News and Savannah. In this competition it is hardly on an equality even, but is subject to many disadvantages; the distance to the Southern ports is less than to New York; the other cities have harbors, which, while not so capacious and deep as that of New York, are still sufficient for the purpose, and the price of real estate and dockage at these several cities is very much less than in New York. If the city and State of New York are to take their chances in open railroad competition, then we must inevitably look to see the relative proportion of exports through New York constantly decreasing, as it has been for the last ten years. While New York may possibly hold its own in the actual volume of business, yet the increase will go to other cities, which, as railroad termini, offer greater advantages for through business; and the relative volume of the business coming to New York will steadily decrease. On the other hand, if the State of New York enlarges its water-way to the utmost limit, then it can be sure that it will offer the lowest transportation rate, and will secure an increasing share of the business, notwithstanding the disadvantages it labors under in the matter of cost of terminals and handling.

Completion of the St. Lawrence Route.

The State of New York must be prepared to face from this time on a serious competition in the export trade over the St. Lawrence route. The Soulanges Canal, which was the last link in the improvements around the rapids of the St. Lawrence River, has been completed during the year 1899 and nominally opened for business. It will be actually opened for business with the spring of 1900. This chain of improvements gives a waterway from Lake Erie through the Welland Canal, Lake Ontario, the St. Lawrence River and its canals capable of carrying boats or barges of about 2,200 tons capacity; the size of the locks is 270 x 45 x 14 ft., admitting vessels 255 ft. long, and 12 to 14 ft. draft, depending on the stage of Lake Erie. The expenditures for construction and enlargement of this route during the last fifty years have been over $56,000,000,* a sum which bears the same ratio to the wealth of Canada as $100,000,000 would bear to the wealth of the State of New York. The distance from Lake Erie to Liverpool by the St. Lawrence route is about 450 miles shorter than by any route across the State of New York.† It is certain that the Canadian government will do everything in its power to realize every possible advantage from this enormous expenditure. Already propositions have been submitted by a group of Chicago and Buffalo capitalists to the Harbor Commissioners of Montreal and accepted by the latter, the result of which will be to divert about 35,000,000 bushels of grain from the New York route. These propositions involve the immediate construction of at least 15 barges of the maximum size which can be used on the canal, and costing $100,000 each, in addition to elevators, warehouses and other structures in the harbor of Montreal, costing more than $4,000,000. These propositions contain no exclusive privileges, and it is open to another group of capitalists to make similar arrangements for the diversion of other large amounts of the grain which now passes through New York.

It is evident that the water route via the St. Lawrence on the one hand, and the short rail lines to Gulf ports on the other, will inevitably prove serious competitors in the future to the export trade of New York. If it desires to retain its export grain trade, it must improve its own water route to the utmost limit of which it is capable; it cannot retain this trade by taking its chances in the railroad competition of half a dozen routes from the lakes to the Atlantic.

Influence of the Canal Upon Iron Manufacture.

It is not alone, however, the export grain trade which requires the enlargement of the Erie Canal. The chief argument for its construction 80 years ago was to have a cheap transportation route for grain and lumber, and this has continued to be its most important function down to the present time. But the changes which are now taking place in the iron trade give reason to believe that if an adequate waterway can be secured between Lake Erie and the Hudson River the center of the iron industry can be brought within the State of New York. This has hitherto been within the State of Pennsylvania on account of its own resources in ores, coal and limestone. But the discovery within a comparatively recent period of almost inexhaustible beds of iron ore in the upper lake region, combined with cheap water transportation on the lakes, has led to the abandonment of its own ore and the substitution of those from the lakes. These ores can be laid down at any point on a water route between Buffalo and New York at less cost than they can be laid down in Pittsburg; there is also a great abundance of suitable limestone within the State of New York and adjacent to the water route; and the improvements which we recommend will make available the Lake Champlain iron ores as well as those of Cuba for a very economical mixture.‡ The only advantage which Pittsburg would have over Buffalo or New York in the manufacture of iron and steel is in its greater proximity to the coking coals. It is believed that this advantage can be overcome by the saving in the cost of ore and limestone and the great saving in cost of transportation of the finished product. Between Pittsburg and tide water the finished product must be transported a distance of 350 miles over a range of mountains, whereas from either Buffalo or New York, or any intermediate point on the water route, the enormous market for steel and iron in New York and New England, as well as abroad, can be supplied at greatly reduced charges for transportation. We believe that a suitable enlargement of the Erie Canal at the present time is justified by the prospect of its use in connection with manufacture of steel and iron and shipbuilding, fully as much as its original construction was justified by the prospect of transporting breadstuffs. Indeed it is not too much to expect that with a canal which can carry manufactured steel from Conneaut to New York for 50 cts. a

*It is stated by Mr. E. L. Corthell (Minutes and Correspondence, page 89), that wheat has been carried from California to England for 3-10 mill per ton mile, and coal on the return trip for 1-5 mill.

†On the lakes return cargoes of coal are carried from Lake Erie to Lake Superior ports, about 1,000 miles, for 25 cents, or ¼ mill per ton-mile.

*Annual Report, Department of Railways and Canals of Canada, 1898, I, p. 43.

†Port Colbourn to Montreal	375	miles
Montreal to Liverpool	3,220	"
Total	3,595	"
Port Colbourn to New York	500	"
New York to Liverpool	3,540	"
Total	4,040	"

Proceedings of Deep Waterways Association, 1895, p. 168.

‡A mammoth steel and iron plant, involving an outlay of more than $20,000,000, is now in process of construction at Buffalo, and plans are projected for another large plant at Tonawanda.

ton, and distribute this from New York to points on the New England coast without breaking bulk, the vast steel and allied industries centering at Pittsburg, which support a population greater than that of Chicago, will seek an outlet for their products by rail to Conneaut and thence by the Erie Canal, rather than across the Alleghenies to Philadelphia.

Within the last ten years the United States have wrested from Great Britain the supremacy in the iron trade, and during that period the imports of iron and steel have diminished from $51,000,000 to $11,800,000 in value,* and the exports have increased from $21,000,000 to $93,700,000 in value.† There is every reason to believe that the iron and steel trade, and the manufactures depending on it, in the United States will continue to increase during the next twenty years in enormous amounts, and it is of the utmost importance that the State of New York shall promptly take steps to bring this industry within its borders, and to provide a cheap transportation route for the finished product both for export and for consumption on the Atlantic coast. Such a route can be provided by the Erie Canal, enlarged as we recommend.

Relation of the Canal to Manufacturing Development.

The possibilities of manufacturing development along the banks of the Niagara River between the Falls and Buffalo should not be overlooked in considering the transportation problem. Factories are already established in the vicinity of Niagara Falls utilizing the cheap power obtained from the Falls to an extent of about 75,000 HP., and these will be doubled within a very few years. The problem of transmission of power has been so far solved as to permit the lighting of Buffalo and the operation of its street car system at a distance of 22 miles from the power house. It is probable that in less than ten years the transmission of power, at least as far as Rochester, will be commercially practicable. These advantages, if properly utilized, will make Western New York the center of such a manufacturing district as the world has never seen. The lakes give cheap transportation to the West, and it only needs a suitable water route to the Hudson in order to give cheap transportation eastward, which will enable these manufactured products to compete in every market in the world.

The Canal as a Regulator of Rail Rates.

The late Mr. Albert Fink, than whom there was no higher authority on the transportation question, made a statement before the Windom Committee some 20 years ago that the Erie Canal regulated the rates not only on the railroads of New York State, but on every trunk line connecting the lakes with the Atlantic. This statement has never been successfully disputed, and it will continue to be true if the canals continue to keep pace with the railroads in enlargement and in management. If the canals are left stagnant, both in size and management, as they have been for a whole generation, while the railroads are improving year by year, then the time will come, and at a very early day, when this statement will cease to be true. To leave the canals in their present condition is virtually to abandon them. The Constitution of New York distinctly forbids this. For more than 80 years public money has been spent on the waterways connecting the Hudson with the lakes, and during 50 years these waterways were enlarged and improved to keep pace with the increase in the traffic, and to decrease the rates. The State has made this expenditure for the purpose of utilizing its natural advantages and keeping within its own limits the route which should produce the minimum freight rate. We believe that the policy which has prevailed in the past, and which has been the chief factor in the commercial prosperity of this State, should be continued in the future. If these views are wrong, then it is in order to stop spending money on the canal and to propose an amendment to the Constitution which will permit of their abandonment and disposal by sale or otherwise. In our judgment, such an amendment to the Constitution would not receive even a respectable minority of votes.

Turning Over the Canals to the Federal Government.

In the southern portion of the State there is a sentiment in favor of turning the management of the canals over to the Federal Government, but this idea is entertained by such a relatively small portion of the people of the State of New York, and its adoption seems to us in every respect so unwise, that we do not deem it necessary to discuss the matter at length. The proposition was brought before the Chamber of Commerce in New York during the year 1898, and a committee reported in favor of it; but on a thorough discussion in the Chamber the arguments in opposition to such a course, and especially those brought forward by Mr. A. S. Hewitt, were so strong that the Chamber unanimously adopted a resolution disapproving of any such course. These arguments, published in the Report of the Chamber of Commerce for 1898, seem to us unanswerable.

What has been said in the foregoing refers especially to the Erie Canal, but it applies equally to the Oswego Canal, which gives access to Lake Ontario, and to the Champlain Canal, which connects the Hudson River with Lake Champlain. We recommend that the project of 1895 be completed, which would provide for boats of 320 tons on the Oswego and 240 tons on the Champlain Canal.

In reference to the minor canals, namely, the Black River, and the Cayuga and Seneca, they were originally intended to be branches or commercial feeders, and in this light we think that they will no longer prove to have much value; but they are of great value as water feeders, and must be maintained for this purpose; and the additional expense of maintaining them in a state suitable for navigation is so slight that we think they should be maintained in that condition. We see no necessity, however, for their enlargement.

*Statistical Abstracts of U. S., 1898, page 252.
†Ibid, page 175; Monthly Summary of Commerce and Finance, Sept., 1899, pp. 675, 820.

II.

The Ship Canal Project.

The enormous interest of the great West in the raising of food products, of which one-fifth is exported for foreign consumption, naturally leads the people of that section to seek the cheapest possible freight line for conveying such products to their final destination. They believe that an all-water route from the upper lakes to Europe will be of great benefit to them in enabling them to compete on more favorable terms with the grain producers of India, Russia and the Argentine Republic. For many years this sentiment has been growing, and it has resulted in Deep Waterway conventions, at which much interesting statistical information has been brought forward, and much accomplished in the way of interchange of ideas. The sentiment of these conventions has been practically unanimous in favor of a water route of either 21 or 28 feet depth from Lake Erie to the Atlantic Ocean. In response to this sentiment Congress has made appropriations amounting in all to $465,000 for the purpose of making the necessary detailed surveys in order that an intelligent opinion could be formed as to the probable cost of such a project. The surveys are being made under the direction of a Board of Engineers on Deep Waterways, and it is anticipated that their report and the result of their surveys will be laid before Congress at the present session. Such a waterway necessarily involves a deep canal across the State of New York, or some portion of it. Two routes have been under consideration, each of which involves a canal around Niagara Falls. The first route leaves Lake Ontario at Oswego, and goes by way of Oneida Lake to the Valley of the Mohawk, and thence to the Hudson. The second route connects the St. Lawrence River with Lake Champlain either though the upper part of the State of New York or through the adjacent portion of the Province of Ontario under some convention with Canada.

Difficulties in the Way of a Ship Canal.

It seems to us that there are certain insuperable difficulties in the way of such a canal ever being a success, no matter by whom constructed. It is intended to be used by a vessel which can navigate the ocean, the canal and the lakes. We do not believe that such a vessel can be constructed so as to be economically and commercially successful. The ocean steamer is built to withstand the fierce storms of the Atlantic, and costs in its most modern type about $71 per net ton of carrying capacity.*

The vessel to navigate the lakes is built to withstand less frequent and dangerous storms; it has less draft, on account of the smaller depth of the harbors on the lakes, and it is built much less substantially; its cost is about $36 per net ton of carrying capacity.†

The cost of a canal fleet, consisting of a steamer and three consorts, with a total cargo capacity of 3,900 tons, according to figures furnished us by boat builders, would be $28,500,‡ or $7.31 per ton.

We have, then, the difference in first cost between $71, $36 and $8 per ton of carrying capacity for the three types of vessels which, in the evolution of business, have been produced as the most economical for the particular class of work each has to do. We do not believe that it is possible to combine these three types into one vessel, which will be as economical for the through trip as to use the three existing types with two changes of cargo, one at Buffalo and one at New York, or to use the boat of 1,000 tons capacity going through from the lakes to New York and there transferring its cargo to the ocean steamer.

The average speed on the Suez Canal is only six miles per hour, and this on a canal with a total length of about 90 miles, of which fully two-thirds is a large lake. In a restricted waterway 350 to 400 miles long we do not believe that ocean steamers or lake steamers could attain an average speed exceeding five miles an hour. They are built to run from 15 to 20 miles an hour, and if they were run at only five miles an hour we think that in order to be profitable the now existing rates on the ocean and lakes of about one-half mill per ton mile would have to be very largely increased.

Finally, we think that this project is not one for serious consideration by the State of New York, because there are as yet no data which would enable any one to give even an approximate estimate of its cost. We have seen various statements placing the cost of a ship canal at figures ranging from $125,000,000 to twice or even three times that sum. None of them are founded on data sufficiently accurate to justify careful examination. The Board of Engineers on Deep Waterways is now preparing such estimates, and these will be the first based on adequate surveys. Until their figures are known, all that we can say is that a ship canal will cost very much in excess of the project which we recommend. On the other hand, it will not, in our judgment, produce a freight rate, or other advantages, commensurate with this increased cost.

While, therefore, it seems eminently a proper subject for consideration by the Federal Government, even though, as is probable, the result of such an examination shall be the abandonment of the project, we do not think it is a subject which should receive any serious consideration from the State of New York.

*Report of Major T. W. Symons, in "Report of Chief of Engineers U. S. Army" for 1897, p. 3174.
†Ibid, p. 3176. These figures were based on the actual cost of vessels constructed between 1893 and 1896. At the present time, owing to the increased price of steel, the cost of each would be largely increased.
‡The Cleveland Steel Canal Boat Co. estimates that steel canal boats of the above capacity (150 ft. long, 25 ft. wide and 10 ft. draft) will cost $15,000 for each consort and $25,000 for a steamer, which is $18 per ton of cargo capacity for a fleet of four boats.

III.

The Project Recommended.

In the foregoing we have given reasons which have led us to the conclusion that it is not wise for the State to abandon its waterway, and that the ship canal will involve an enormous expenditure without producing a satisfactory result. It then remains for us to consider to what extent the waterway across the State should be enlarged. A number of projects have been under consideration, involving plans for a canal of different depths, from 9 to 14 ft., carrying boats with capacities of from 320 to 1,500 tons, and involving an expenditure of from $13,000,000 to $80,000,000. In order to arrive at an intelligent decision, it is necessary to determine with reasonable accuracy what each of the proposed projects will produce in the way of freight rate, and what it will cost.

Estimates of Cost of Construction.

In regard to the latter, the information and data which have become available within the last few months are far more extensive than were at the disposal of the State Engineer when the project of 1895 was prepared, or at the disposal of Major Symons when he made his report to the War Department in 1897 on the barge canal project, or at our own disposal when we sent out our circular letter of May 1st, 1899. The surveys of the Board of Engineers on Deep Waterways have been of the most thorough and complete character, and covered every possible route for a waterway through this State east of Oswego and Syracuse. The results of these surveys will not be available to the public until after the report shall be presented to Congress, which it is anticipated will be done during the present season, but through the extreme courtesy of the members of the Board their records and surveys have been placed at the disposal of engineers employed by us. The engineers of the State while the project of 1895 was being carried out made very complete surveys in the immediate vicinity of the canal, including cross sections at intervals of 100 ft. In order to obtain the data for estimates on the portion of the route west of Syracuse and Oswego we have employed our own engineers, who have made their own surveys. Finally, we have had the advantage of the maps of certain portions of the State recently published by the United States Geological Survey on a scale of 1-62500, or about 1 in. to the mile, with contours at 20 ft. interval. With all of this data it has been possible to prepare estimates of cost which we feel justified in relying upon as sufficiently accurate to form a basis for recommendations to yourself and the Legislature. These estimates will be found on pages 81 to 107. They were prepared by Messrs. G. W. Rafter, D. J. Howell and F. M. Sylvester, all of whom have had long experience in engineering work connected with the canals. They were made under the personal direction of Major Symons, and have been carefully examined and approved by him. They have been further examined and approved by Messrs. William H. Burr and William Barclay Parsons. The original estimates of Messrs. Rafter, Howell and Sylvester, covering nearly 300 pages of typewritten manuscript, are considered too voluminous to be published in extenso with this report, and have therefore been deposited in the office of the State Engineer. They contain data of great value on the canal question, and we recommend their publication by the State.

It should be further noted that our estimates provide for the construction of mechanical lift locks at Cohoes at the risk and expense of the State. Chapter 519 of the Laws of 1899 provides a method by which these locks can be constructed by private capital at its risk, the State paying a rental in case of success. Should this method be put into practical operation, our estimates will be reduced by $1,200,000 for the smaller project, and $1,700,000 for the larger project.

We fully realize the responsibility attached to the making of these estimates, and we feel that we have taken every precaution within our power to avoid the error of estimating below actual cost. While further surveys are

necessary in order to make working plans and prepare contracts (and we recommend that such surveys be made immediately), yet we feel reasonably confident that the figures we now present are sufficiently accurate as a basis for legislation and a vote of the people, and we think the result of further surveys will be to decrease to some extent the estimates we now present.

Estimates of Cost of Transportation.

The other factor in the problem is to determine the probable freight rate; or, more exactly, the actual cost of transportation, which will result from carrying out each particular project under consideration. Major Symons has made a most careful study of this feature, and has procured from boat builders, canal boatmen, and from every other available source the data bearing upon the actual cost of running boats of different sizes. It is believed that every item of cost, expense and depreciation has been fully taken into consideration. As a check upon the figures obtained in this manner, we have had the actual freight rates in force upon the Lakes and upon the canals under existing circumstances. The foregoing explanations are given so that every one can determine just how much weight to attach to our figures.

Previous Improvements of the Erie Canal.

The Erie Canal was originally built with locks 90 ft. long, 15 ft. wide and 4 ft. deep, and with a prism of corresponding depth. The boats first used carried 30 tons. It has been successively enlarged at different times. At the end of 1862 it had double locks, 104 ft. long, 18 ft. wide and 7 ft. deep, and carried boats of 240 tons. No improvements have been made during the last 37 years, except to lengthen the locks on one tier so as to pass two boats at one lockage. This work had been completed on all the locks except at the four flights of Cohoes, Little Falls, Newark and Lockport. It was anticipated that at these points modern lift locks would be desirable, and that it was unwise to expend any money in lengthening the locks of the old pattern. This was the condition of the canal at the time of the adoption of the project of 1895 (Chapter 79 of the Laws of 1895). This law described the project in the following language:

> The said improvement to the Erie and Oswego canals shall consist of deepening the same to a depth of not less than 9 ft. of water, except over and across aqueducts, miter sills, culverts and other permanent structures, where the depth of water shall be at least 8 ft., but the deepening may be performed by raising the banks wherever the same may be practicable; also the lengthening or improving of the locks which now remain to be lengthened, and providing the necessary machinery for drawing boats into the improved locks, and for building vertical stone walls where, in the opinion of the State Engineer and Surveyor and Superintendent of Public Works, it may be necessary. The improvement upon the Champlain Canal shall consist in deepening the said canal to 7 ft. of water, and the building of such vertical stone walls as in the opinion of the State Engineer and Surveyor and Superintendent of Public Works shall be necessary. The work called for by this act shall be done in accordance with plans, specifications and estimates prepared and approved by the State Engineer and Surveyor.

The contracts let under this project were all upon the prism and none upon the locks (except at locks 21 and 22). The plans and estimates, so far as we can learn, contemplated locks which would provide for the passage of two boats, each 104 ft. long, 17½ ft. wide and about 7½ ft. draft. It was estimated that this would increase the carrying capacity of the boats about one-third, namely, from 240 tons to 320 tons. This is what we understand to have been the project of 1895.

In his report for 1897, State Engineer Adams recommended the lengthening and deepening of the locks by the use of a different type of gate, so as to provide for boats of 115 ft. in length, 17½ ft. wide and 8 ft. draft. This would increase the carrying capacity of the boats to 400 tons.

In the report of Messrs. North and Cooley, the Engineers of the Investigating Committee of 1898, it was pointed out that many items had been omitted in the project of 1895, such as "the strengthening of banks and repairing or renewing of locks, aqueducts, waste weirs, etc. * * * all locks deepened and lengthened or replaced with pneumatic lifts as at Lockport and Cohoes. * * * and pneumatic lifts at Newark and Little Falls." The carrying out of this additional work necessarily increased the estimates of the engineers of the Investigating Commission beyond those of the State Engineer.

Investigations of Various Projects.

We have considered the cost and value of the original project of 1895 when completed; as well as that including the modifications suggested by Messrs. North and Cooley, and we have also considered the cost of a similar project with locks sufficient to take two boats, each 125 ft. in length, 17½ ft. in width, 8 ft. in draft, with a cargo capacity of 450 tons. We also considered the cost of widening one tier of locks so as to pass boats 125 × 25 × 10 ft., with the idea that these boats might be temporarily used on a 6 ft. draft, and thus derive a partial advantage in the increased cargo and decreased freight rate, pending the final completion of the project. This plan was very favorably received by boatmen and others interested in canal transportation, and this led us to make a very careful examination and test of the accuracy of the estimates of cost which we had used in our circular letter of May 1 as a basis for discussion, and which had been obtained from such published data as were then available. The result of such examination showed that the figures which we had been considering were erroneous. We also caused plans to be made of the sharp bends and other points of the canal where the navigation by boats 25 ft. wide pending the enlargement would be difficult, and the result of such examination clearly convinced us that such boats could not be used to advantage until the final completion of the entire project. We also learned that a similar plan of temporarily navigating the canal on a single track basis with turnouts had been tried during the enlargement of 1855 and found to be impracticable. We were therefore compelled to abandon further consideration of the project designated as "Plan 2" in our circular letter of May 1. (Eng. News, May 11, 1899.)

We have also considered with some care the project of a barge canal for barges of 12 to 14 ft. draft, and capacity of 1,200 to 1,500 tons; but we became convinced that a barge of this size would cost very much more than a barge of 1,000 tons capacity; that the corresponding canal would cost very much more than the canal suitable for the 1,000 ton barge, and that the cost of transportation, or freight rate, would be substantially the same in both cases. We therefore have not made any detailed estimates of the cost of a barge canal for 1,500 ton barges.

The result of the investigation, therefore, reduced the number of projects to four, and the cost and economic value of each have been very carefully considered. The results are given in tabular form herewith. In considering the three smaller projects, we became convinced that the completion of the project of 1895, as originally designed, and producing a waterway to be used by boats of 320 tons, would produce so slight an improvement over existing conditions as not to justify the expenditure of public money. As between the projects for boats 115 ft. or 125 ft. in length, each having 17½ ft. width and 8 ft. draft, we concluded that the increased saving in transportation cost by the larger boat was sufficient to justify the increased expenditure.

We thus eliminated from consideration all of the various projects except two, and the relative advantages of these will be stated in some detail in order to explain fully why we have finally decided to recommend the larger project.

Cost of Transportation by Present Erie Canal and Same Canal Improved to Different Capacities.

	Present Erie Canal.	Erie Canal completed under $9,000,000 project.	Erie Canal completed—Under $9,000,000 project and same farther extended to allow use by boats 115×17½×8-ft. draft.	Erie Canal completed—In accordance with project of Canal Committee, for use by boats 125×17½×8-ft. draft.	Recommended canal for barges 150×25×10 ft. draft.
Cost of transporting:					
1 ton of freight, Buffalo to New York.....	87 cts.	58 cts.	50 cts.	44 cts.	26 cts.
1 bushel of wheat, Buffalo to New York..	2.62 "	1.75 cts.	1.51 cts.	1.32 cts.	0.80 cts.
Per ton per mile	1.75 mills	1.16 mills.	1 mill.	0.88 mill.	0.52 mill.
Assuming 10,000,000 tons annually between Buffalo and New York, would be.....	$8,700,000	$5,800,000	$5,000,000	$4,400,000	$2,600,000
Under above assumption, annual saving in cost over present Erie Canal would be.....	.....	$2,900,000	$3,700,000	$4,300,000	$6,100,000
Relative cost of transportation, assuming that by present Erie Canal as unity.....	$1.00	$0.67	$0.57	$0.50	$0.30
Relative value of canals considering cost of transportation simply*	$1.00	$1.50	$1.74	$1.98	$3.34
Assuming 10,000,000 tons annually; saving of cost of transportation as per this table; money at 5%; the economic value of different size canals over present would be	.....	$58,000,000	$74,000,000	$86,000,000	$122,000,000
Estimated cost of completing Erie Canal to extent indicated.	.....	$12,923,639	$15,068,048	$21,161,645	$58,894,068

*Present Erie Canal as unity.

Changes to be Made in Locks.

Each of the projects contemplates that the first work to be done will be that upon the locks so as to fix the size of the boats, enable builders to resume the building of boats, and pending the completion of the prism to pass three of the present boats at one lockage. There are two points on the canal where an entirely different system of locks should be introduced; one at Cohoes, where a double pneumatic or other mechanical lift should replace the existing sixteen locks; and the other at Lockport, where a similar lift should replace the existing five locks. There are two other points, namely, Little Falls, where the four existing locks should be replaced by three new locks; and Newark, where the three existing locks should be replaced by one new lock. At other points the existing locks are to be rebuilt with greater length and greater depth. Each plan also contemplates the use of quadrant gates in place of the present gates, and of mechanical power, either steam or electricity, for operating the gates and for working the boats into and out of the locks.

Changes in Route.

Each plan also contemplates a new canal for about 100 miles, or 30% of the entire length. One diversion is from Clyde to New London, following the line of the Seneca and Oneida rivers and Oneida Lake, avoiding the treacherous foundation which is such a fruitful source of expense across the Montezuma marshes, and giving a wide waterway through the rivers and lake above mentioned, so as largely to increase the speed of the boats. The other diversion is to begin at the West Troy side cut (cutting out two locks and seven miles of canal between that point and Albany), and construct a new canal leaving the Hudson River at the West Troy side cut and following the line of the existing Champlain Canal, and the bed of the Mohawk River to the Cohoes Falls; to canalize the Mohawk River from the falls to Rexford Flats, near Schenectady, and possibly as far up as Little Falls, if the result of further surveys shall show that this is cheaper than to follow the present route. The canalization of the Mohawk River between Cohoes and Rexford Flats will do away with the two aqueducts, the expense of rebuilding which on either of the plans for enlargement would be very great.

The aqueduct at Rochester, and the line of the canal through that city, are so located that the expense of enlargement will be almost prohibitive, and we therefore advise the adoption of a new line to the south of Rochester, as is fully set forth in the estimates of the engineers. The adoption of the new line btween Clyde and New London would carry the main canal about six miles north of Syracuse, but an outlet is provided for into Onondaga Lake, where large and satisfactory terminal facilities can be provided for the benefit of the Syracuse trade at comparatively small expense.

Our estimates provide for carrying the enlarged canal through the city of Utica on the present route, but further surveys are necessary to show whether it would be cheaper to carry it around the city of Utica.

For many years it has been suggested by engineers that it would be desirable to carry the canal between Clyde and some point in the vicinity of Rome by a southern route which should give a constantly descending canal from Lake Erie to the Hudson River. It has also been suggested that the Syracuse level might be extended east and west so as to provide a constantly descending canal. These projects were so attractive that we employed Mr. George W. Rafter to ascertain definitely what they would cost. His complete report has been filed with the State Engineer, and we recommend its publication. He surveyed one route to the south of the present line, one to the north, and one intermediate for extending the Syracuse level east and west. His surveys showed that the cost of the southern route, 58 miles in length, would be $29,000,000; the northern route, 58 miles, would cost $22,400,000, and to extend the Syracuse level east and west, 113 miles, would cost fully $32,500,000. These estimates are based on a canal of 12 ft. depth, sufficient to carry boats 25 ft wide and 10 ft. draft. The adoption of either of theso routes would involve a cost of from $17,000,000 to $25,000,000 in excess of the route which we recommend by the Seneca and Oneida rivers and Oneida Lake. In our judgment, no advantage would be gained corresponding with such an increased cost, and we therefore advise the adoption of the route via the Seneca and Oneida rivers, and Oneida Lake.

Comparative Capacity and Costs of Transportation on the Two Canals.

The route to be followed by either of the two projects which we now submit is therefore the same, and the difference in cost is that which arises from the difference in the size of boats and the difference in the size of locks and prism to carry them. The smaller project is for boats 125 ft. in length, 17½ ft. in width and 8 ft. draft, and a capacity of 450 tons; and the larger project is for boats 150 ft. in length, 25 ft. in width and 10 ft. in draft, with a capacity of 1,000 tons. The cost of transportation in one case will be 0.88 of a mill per ton mile, or 1½ cts. per bushel of wheat from Buffalo to New York; and in the other case 0.52 of a mill per ton mile, or 8-10 ct. per bushel of wheat from Buffalo to New York. The cost of transporting a ton of freight from Buffalo to New York by the smaller project will be 44 cts., and by the larger project 26 cts. The smaller canal will have a capacity of 10,000,000 tons per annum, and on that tonnage the saving, as compared with the present canal, will be $4,300,000 per annum; on the same tonnage, the saving by the larger canal will be $6,100,000 per annum, but its capacity would be in excess of 20,000,000 tons per annum, and on that tonnage the saving, as compared with the present canal, would be $12,200,000 per annum. As compared with the

lowest rail rate ever quoted across the State of New York, the saving on a tonnage of 20,000,000 tons per annum would be nearly $18,000,000 per annum.

Why the Larger Project Is Recommended.

As between these two projects, the undersigned are unanimously of the opinion that it is best for the State to adopt the larger project. Whether these views will meet the approval of the Legislature and the people it is not for us to say. We confine ourselves solely to advising you what in our judgment is the proper policy for the State to pursue in regard to its canals, leaving to those on whom the responsibility rests to decide whether these views should be carried into effect. We feel confident that on mature reflection the Legislature and the people of the State will ultimately adopt these views. We have hesitated to recommend the expenditure of a sum of money which, although small in proportion to the resources of the State, is still a very great sum; but after much deliberation we are unwilling to recommend any temporary or partial settlement of the canal question. We do not believe that the adoption of the smaller plan will result in permanent benefit to the State of New York, and as the money expended on the smaller project would be almost entirely wasted in case a larger project should be determined upon later on, we do not feel justified in recommending the expenditure of so large a sum as $21,000,000 for a temporary purpose. We feel confident that the larger project will result in a transportation cost across the State of New York as low as that by the St. Lawrence canals, which constitute their chief rival at present, far less than any rate which is possible by railroad at any time within the immediate future, equal substantially to the results which could be obtained by a large barge canal or a ship canal, and, in short, would be a complete and permanent solution of the canal problem. It would give New York advantages in the low cost of transportation, and the commerce resulting therefrom which would be possessed by no other State on the Atlantic Coast.

We believe it is unwise to spend large sums of money in a mere betterment of the existing canal; what the present situation requires is a radical change, both in size and management, and what we recommend is practically the construction of a new canal from Lake Erie to the Hudson River, following the present canal for something over two-thirds of the distance, and new routes for the remaining distance of a little less than one-third, and utilizing the existing structures and prism so far as they can be made use of. We are firmly of the opinion that any less complete solution of the problem will in the end prove to be unsatisfactory; and that while the sum of money required to put this into execution is large, yet the resources of the State of New York are so enormous that the financial burden will be slight.

Work on the Smaller Canals.

In regard to the Oswego and Champlain canals, we think the project of 1895 will afford an adequate solution, and that this project should be completed. The State has already expended on these two canals since 1895 $2,841,000. The cost of completing them now, owing to the eight-hour law and the increased price of materials, will be as follows:

For the Oswego Canal*	$818,120
For the Champlain Canal	1,824,000
Total	$2,642,120

We have carefully considered the substitution of the Hudson River for the Champlain Canal between Fort Edward and West Troy, but we find that this will add about $2,000,000 to the cost, and we do not think that the benefits will justify this additional expense. Subsequent surveys may show that for a portion of the distance it may be possible to utilize the Hudson River at a smaller expense than the estimates we submit for the corresponding portion of the canal.

The completion of this project will give a prism of 9 ft. depth and structures with 8 ft. depth of water on the Oswego Canal, making it suitable for boats of 320 tons capacity; and on the Champlain Canal will provide a prism of 7 ft. in depth, with 6 ft. of water over structures, capable of transporting boats of 240 tons.

IV.

Finances.

In this chapter, the Commission discusses the financial aspects of the canal question. A careful audit of the receipts and expenditures on each of the State canals since their construction shows that:

The minor canals have resulted in financial loss, and several of them have not even paid any appreciable return upon the sum expended in their construction. Several of the latter, such as the Genesee Valley, Chenango and Chemung canals were abandoned some years since, and it must be frankly admitted that their construction proved to be a mistake, and the sums expended on them were a total loss.

The Erie Canal shows a different result. Excluding interest from the account, at the close of 1882, when tolls were abolished, the total expenditures upon this canal for construction, enlargement, repair, maintenance and operation had amounted to $78,862,154, while the total receipts from tolls were $121,461,871, leaving a profit to the State of $42,599,718. Including all the expenditures on the canal since 1882, there still remains over $20,000,000 to the credit of the Erie Canal. "Had not this canal showed this large profit in the past, the committee would not now advise its enlargement."

In considering the question as to how the money for canal enlargement should be raised, the committee has decided that an equitable plan would be by a tax upon the counties bordering the canal and the Hudson River. These counties contain 90% of the total valuation of the State, and 80% of the total population. New York city alone now pays 62% of all the taxes in the State, and under the proposed assessment would pay 69% of the cost of improvement, a proportion deemed not unjust, as a large reason for the improvement is that it may secure to that city a commanding position in the export trade. This method of assessment has been approved as to its legality by the Court of Appeals, and was actually adopted in raising money for canal expenditures in 1817.

While the proposed expenditure of about $60,000,000 is a large sum, it would amount to only 1½% on the assessed valuation of the counties on which it is proposed to lay the tax; and the interest and sinking fund requirement on an issue of 18-year bonds to this amount would increase the annual State tax only 10 cts. on each $100 of valuation. For the benefits above recited, the Commission thinks this a very small sum to pay, and shows that this is a far smaller tax than was paid by the State for the original construction and enlargement of its canals.

V.

Management.

As stated in the beginning of this report, in our judgment the efficiency of the canals depends quite as much upon the way the business is handled on them as upon their physical size, and we advise against the expenditure of any more money for their enlargement unless it shall be accompanied with measures which will lead to the adoption of more modern methods in conducting the business of water transportation across the State. The policy of the State hitherto has been to discourage the adoption of modern business methods and to foster the handling of the traffic by canal boatmen owning each a single boat, or small companies owning a few boats. This prevents the State from taking advantage of those improvements in business management which have brought about such enormous economies in other lines. Canal legislation has been largely in the interest of the comparatively small number of canal boatmen, but it has resulted in failure so far as they are concerned, for experience has shown that they are unable to cope with the methods employed through corporate action.

Why Railways Obtain Traffic at Higher Rates Than the Canal.

The statistics which accompany this report show that in 1868 the canals carried 44% of the tonnage across the State, and in 1898 only 5%. In the matter of grain (including flour) in 1868 the canals carried 76%, and in 1898 10%. Yet during all of these 30 years, the rail rate has always been in excess of the canal rate. There must be a reason why shippers and merchants are willing to pay more for transporting grain and other articles by rail than by canal, and the reason is chiefly because the railroad conducts the business according to modern methods and the canals do not. There is, in our judgment, no reason why the same business methods cannot be applied to the canals as to the railroads; and if they are applied they will produce an equally satisfactory bill of lading, equal certainty in the time of delivery and equal responsibility on the part of the carrier.

In order to accomplish this, so much of chapter 934 of the laws of 1896 as limits the amount of capital which shall be employed in the business of canal transportation should be repealed. This law reads as follows: "No corporation organized under this act, and designed to navigate any of the canals of the State, shall have a capital stock exceeding $50,000." It has been charged on the one hand that this law was passed at the instance of the railroads in order to destroy the usefulness of the canals; and, on the other hand, it is asserted that it was passed for the benefit of the boatmen in order to prevent the formation of large corporations, which, by greater economy, could first drive the small boatmen out of the business, and then by some alliance or understanding with the railroads, increase the rates. Whatever the origin of the law may have been, it has proved in practice to be of no benefit to the boatmen. Their business has continued to diminish and to grow still less profitable year by year since this law was passed. They do not make living wages under existing conditions, and they cannot. They are attempting to maintain an antiquated method of business in competition with the modern methods which have brought about the extraordinary increase of wealth during the last 30 years. They cannot possibly succeed, and the State is not justified in expending any more public money unless the conditions are so changed as to derive the full benefit from its investment. We therefore recommend in the most positive terms that the above quoted law of 1896 be repealed.

Reduction of Terminal Charges.

The next step is the reduction of terminal charges at Buffalo and New York. The improvements which we recommend are designed to produce a freight rate not to exceed 1 ct. per bushel from Buffalo to New York. The prevailing rate on the lakes from Chicago to Buffalo during the last few years has been 1½ cts., making a total of 2½ cts. for transportation alone for a distance of 1,500 miles. The cost of handling at Buffalo and New York is 2 1-10 cts., made up as follows:

		Cts.
Elevator charges at Buffalo		.625
Receiving, weighing and discharging at New York	Per 1,000 bu. $6.25	
Canal boat trimming	" " " 1.50	
Ocean vessel trimming	" " " 2.00	
Floating elevator	" " " 5.00	
	$14.75	1.475
Total for rehandling		2.100

We think that the cost of rehandling is out of proportion to the cost of transportation. It is equivalent to 78 cts. per ton. Ore and coal are handled at terminal points on the lakes, in large quantities, at a cost of 8 to 10 cts. per ton. We believe that the grain can be handled at a cost per ton little, if any, in excess of ore and coal.

Within the limits of the present city of New York and within the new harbor of Buffalo, there are miles of unoccupied and cheap water front where suitable structures and appliances for handling the grain out of the lake steamer into the canal boat at Buffalo and out of the canal boat into the seagoing vessel at New York, can be erected, the result of which will produce a reduction in the grain rate fully equal to that which can be produced by an enlargement of the canal. If the elevator charges are not voluntarily reduced, then, with the waterway enlarged and made free as we recommend, the grain will be sent through from Chicago to New York in a fleet of four or six barges (133,000 or 200,000 bushels) without breaking bulk. This, combined with the Montreal competition, will soon force the adoption of improved and cheaper methods of rehandling.

We do not believe that it is necessary to attempt to bring about these results by legislation. If the use of the canal is made free, without restriction as to amount of capital employed, these results will be brought about in the natural course of trade and competition.

Introduction of Ore-Handling Methods in the Grain Business.

Again referring to the iron trade and the marvelously cheap cost of transporting ore, we find that this business is managed by large concerns owning their own mines, their own lake vessels, and their own railroad from the lake port to Pittsburg. At the points where bulk has to be broken, modern mechanical devices are installed for handling the material out of one carrier and into another in enormous quantities and at a minimum cost. We believe that, if the canal is enlarged and made free, analagous methods will be introduced in the grain trade under which responsible companies with adequate capital will take charge of the grain at Chicago or Duluth and deliver it in the hold of the seagoing vessel at New York, making use at all points of the line of their own property in lake steamers, elevators (both movable and floating), canal boats, and tow boats, and giving one through bill of lading. Such companies, it is hardly necessary to say, would not tolerate the antiquated method of hauling canal boats by horses or mules; self-interest would prompt and compel them in a very short time to find the best means of mechanical traction, whether by steam or electricity, whether to have the motive power in each boat, or to have a self-propelled boat which carries freight as well as tows other boats, or to have the motive power in a boat which carries no freight, but is used only for towing. The cost and methods of traction would be studied by such a transportation line with the same care that railroads now study improvements in locomotives, and the result would be constant improvements in the method of traction similar to those which have been in progress on the railroads for the last 30 years, and have resulted in the low rates which have practically driven the old-fashioned canal boat and methods out of the contest. Such a transportation line with such appliances would be able to run boats through the canals on schedule time, and with a more certain adherence to their schedule than the railroads make with their freight trains. It is well known that the schedule time of the lake steamers is far more certain than that of the freight trains on the railroads paralleling the lakes. The canal boats ought to be able to make at least 4 miles an hour, including lockage, night and day, which would bring the time from

*The work on the Oswego Canal between Syracuse and Phoenix is provided for as part of the Erie Canal enlargement.

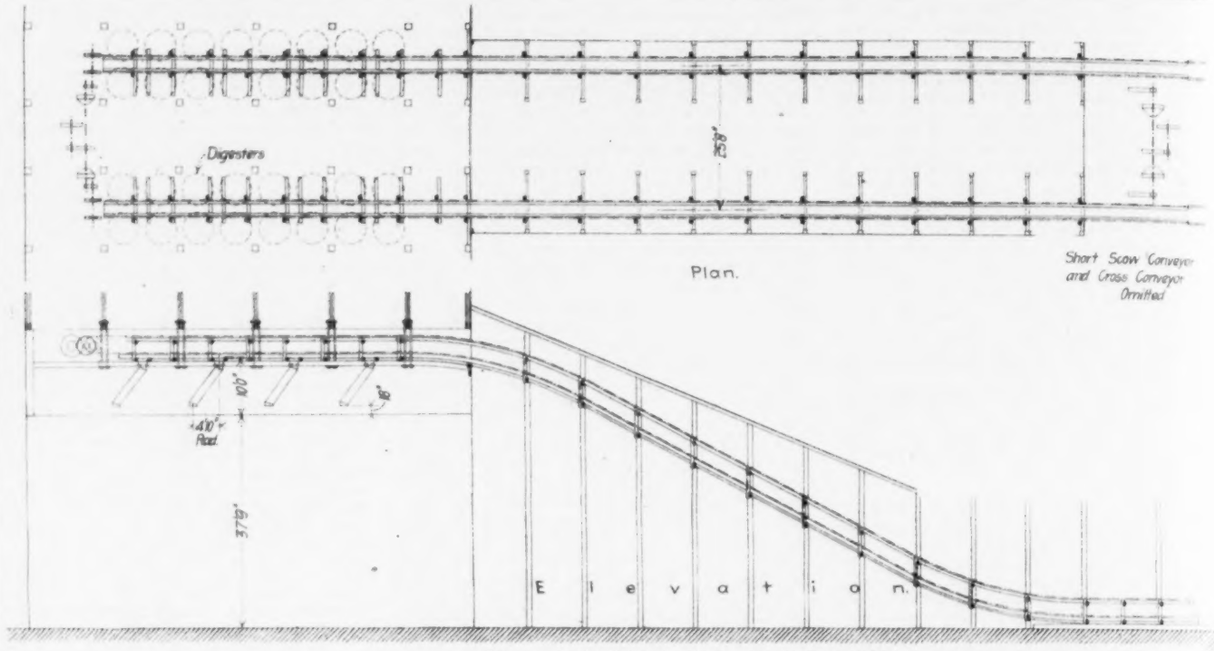


FIG. 5. CONVEYOR SYSTEM FOR GREEN GARBAGE.

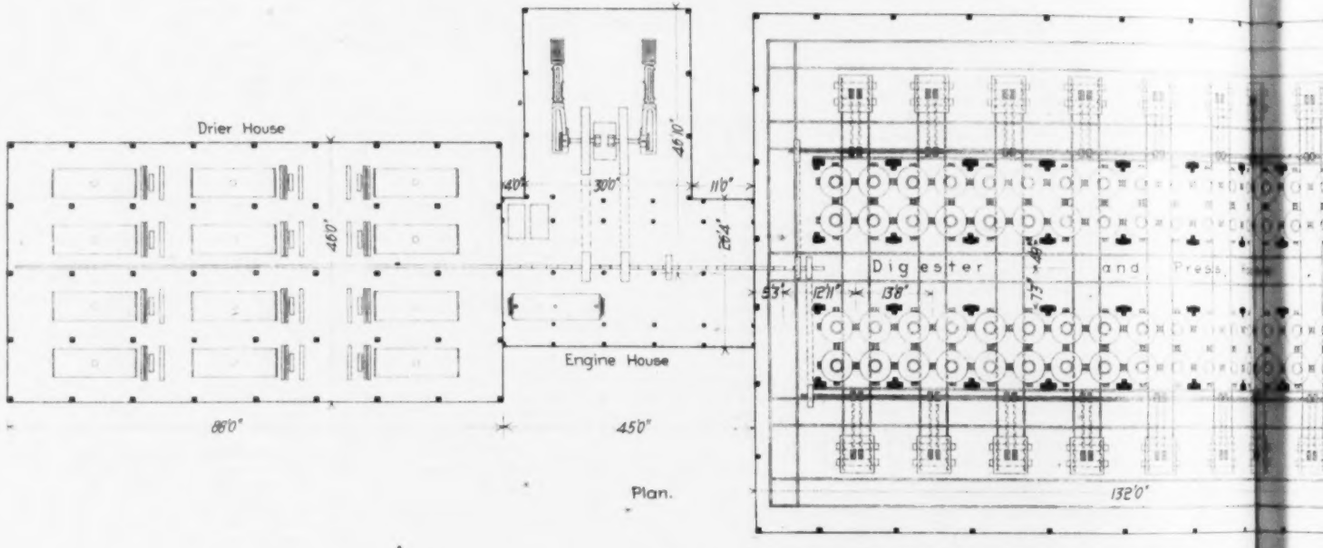


FIG. 4. PLAN AND CROSS-SECTION OF DIGESTER AND PRESS, ENGINE AND DRIER HO

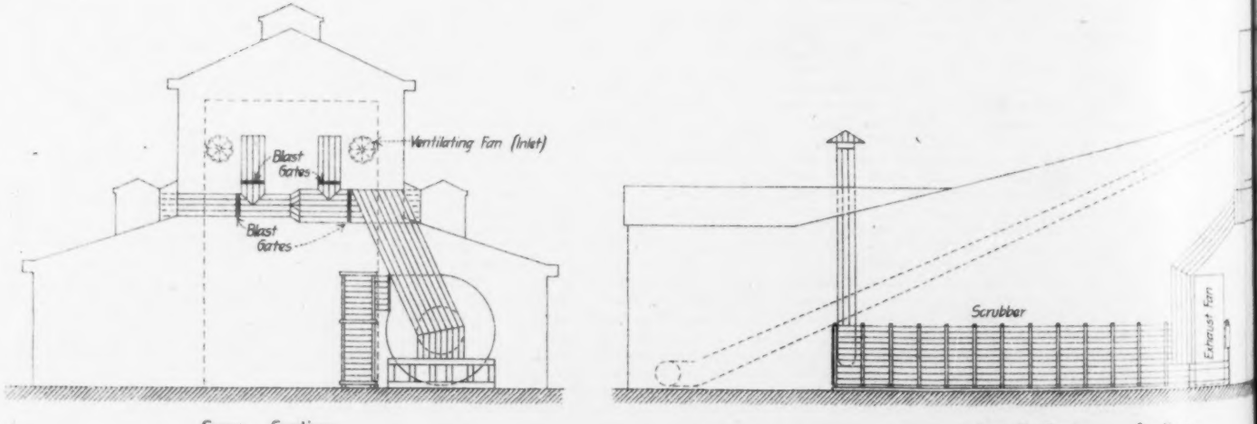


FIG 6. VENTILATING, CONDENSING AND GAS WASHING SYSTEM.

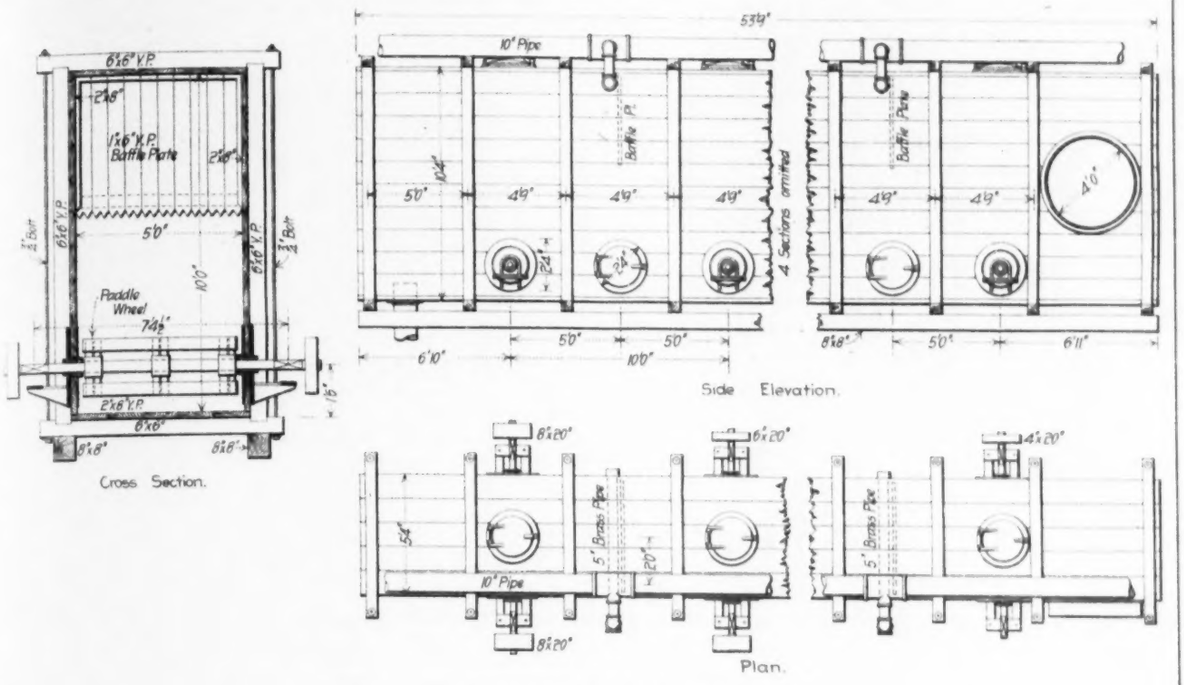
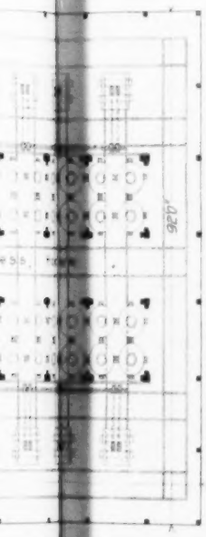
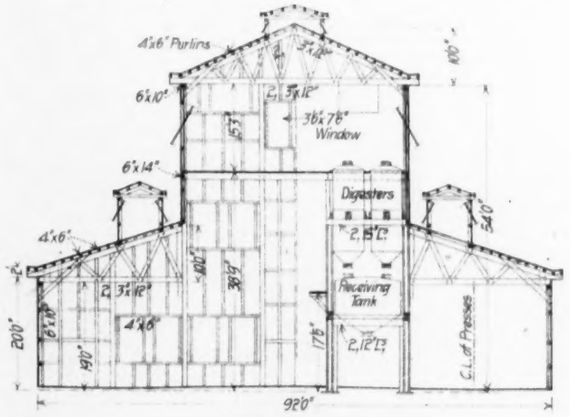
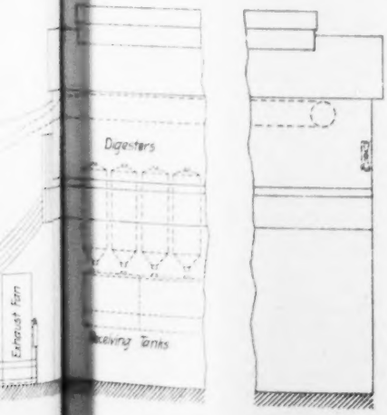


FIG. 7. DETAILS OF GAS CONDENSER AND SCRUBBER.







BARREN ISLAND
GARBAGE
REDUCTION WORKS
OF THE
NEW YORK SANITARY
UTILIZATION CO.
AND THE
BROOKLYN
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OF
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Charles Edgerton, M. E.,
Engineer,
Philadelphia, Pa.

CHAS. HART, LITH., 86 VESEY ST., N. Y.

Buffalo to New York down to 126 hours, or 5¼ days, in place of about 12 days, as at present.

Improvements in Locks.

The other points where we think the canal management is open to great improvement relate to matters entirely within the control of the State, namely: the kind of locks, and the method of handling the locks; the efficiency of the force engaged in the engineering and management of the canals; and the method of carrying on public works by contract. On these points we think legislation is desirable, as well as a more business-like enforcement of the laws, than has hitherto prevailed.

In regard to the locks, we have explained on a previous page the modern arrangement which we think should be introduced at Cohoes, Little Falls, Newark and Lockport, which will reduce the total number of locks from 72 to 54; this will save at least 8 hours in the time of passage, and will dispense with the services of a great number of lock tenders. At the remaining locks it is possible to use an improved modern type of gate, occupying much less space than the old-fashioned gate, invented about 400 years ago, and to operate these gates by mechanical power at a still further reduction in the expense for management.

Responsibility of Canal Officials and Introduction of Civil Service Methods.

In regard to the force engaged on the canals and other public works of the State, the State Constitution provides for a State Engineer and a Superintendent of Public Works, and defines their duties. It is impossible to change the Constitution in this respect, if it were desired. In point of fact, the only serious objection we see to the system is that these officers have equal powers and responsibilities, and neither is subject to the other. So long as they work in harmony all goes well, but if they see fit to antagonize each other there is an opportunity for a deadlock, and delay and confusion in the transaction of public business. The system cannot, however, be changed in any reasonable time, and must be accepted. Except in the matter of their having co-ordinate powers, it is not different from the system pursued by railway, steamship or any other transportation lines, in every one of which there is a manager or superintendent at the head of the operating department, and a chief engineer to supervise the engineering work. The Constitution provides that the State Engineer shall be elected by the people for a term of two years, and the Superintendent of Public Works appointed by the Governor for the period of the latter's term. It is not possible to amend the Constitution in these respects, and it is therefore useless to discuss any other method. That prescribed by the Constitution must be followed, and the people or Governor must be relied upon to put competent men in these places.

The Constitution further provides that the Superintendent of Public Works shall appoint not more than three assistant superintendents, and that he shall appoint all persons employed in the care and management of the canals, except collectors of tolls and those in the Department of the State Engineer, and that all his appointees shall be subject to suspension or removal by him. The Legislature, however, has power to prescribe the duties of his assistants, and to fix their compensation. As to the employes under the State Engineer, the Constitution is silent.

If the Erie Canal is enlarged in the manner we recommend, and becomes again a large factor in the transportation question in this State, the work in its two departments of engineering and management, as well as the minor public works of the State, will afford a life career to the graduates of scientific institutions which they would gladly enter if they could feel sure that their tenure of office depended on good behavior, their promotion upon merit, and that they were not liable to be turned out at any moment for some political reason. While the Constitution places in the hands of the Superintendent of Public Works the power of appointment and removal in his department, yet the law has already restricted his absolute power in the matter of appointments by prescribing examinations and tests of fitness which must be passed before he can make the appointment; and similarly, the Legislature can restrict his power of removal so as to limit it to removal for cause. It is also competent for the Legislature to classify and grade the permanent employes in both the public works and the engineering departments; to prescribe that appointments shall be made only in the lowest grade, and that promotion from one grade to the next higher shall be made after a suitable examination. We recommend that such legislation be passed; and we consider this essential in order to secure permanently an efficient, honest and economical administration of the canals and other public works of the State. If the State creates a service in which men will take pride in serving, and removal from which will constitute a stigma of disgrace, it will be able to secure for this class of work men of a higher order of ability, integrity and character for a comparatively small compensation. We believe that a unique opportunity now exists for establishing the service of the public works in this State on this basis, to have such legislation firmly planted in the statutes of this State, and to get the system fairly inaugurated and put into practical operation. Your own experience in these matters so far exceeds that of any member of the committee that it seems to us unnecessary that we should attempt to point out in detail the character of this legislation. We have only to call your attention to the matter, and to state that in our judgment the proper administration of the canals and other public works requires legislation which shall prescribe tenure of office during good behavior, appointment only to the lowest grade, promotion from one grade to the next by selection, both appointment and promotion to be determined by suitable tests, and no removals to be made except for cause.

Methods of Preventing Fraud and Loss in Contract Work.

Finally, we think that the laws in regard to the letting of public contracts by the State can and should be revised so as to make impossible a repetition of the unfortunate results under the nine million dollar appropriation. These results, under the present law, were unfortunate in the following respects: An unnecessary expenditure for advertising; a loss of public money through unbalanced bids; and an unnecessary expenditure through the use of forced account. The report of the Investigating Committee appointed by Governor Black fully pointed out these facts, and it only remains for us to suggest such legislation as in our opinion would prevent them from occurring again.

In the matter of advertising, Chapter 794 of the Laws of 1896 required the work to be advertised in the State paper for ten successive days, and in such other newspapers as the Superintendent of Public Works may select. We recommend that this be repealed, and in place thereof a statute be enacted similar to the statute now in force in the city of New York (Section 66 of the Consolidation act), under which all advertising for the State shall be confined to the State paper, but allowing brief advertisements, calling attention to any contracts intended to be awarded and referring for full information to the said State paper, to be published in not exceeding two newspapers in each of the ten principal cities in the State.

In regard to the use of force account and extra work, we recommend that a statute be enacted providing that extra work shall be authorized only by the authority of the State Engineer and the Superintendent of Public Works, expressed in writing, and in no case shall such extra work (including force account) be authorized to an extent in the aggregate exceeding 10% of the value of the contract as determined by the bidding sheets.

We also recommend that the statute require that the bids shall not only be opened in the presence of bidders, but shall be publicly read in their presence; which, as stated in the report of the Investigating Committee appointed by Governor Black, was not done.

As to unbalanced bids, they have been used upon the Erie Canal for a great many years. They were brought out in the Tilden investigation, and they were again shown up in the report of the Investigating Committee of 1898. The State has lost large sums of money from this cause, and there will probably be the same trouble in any future canal work unless some different system of bidding is adopted. We recommend for adoption, by statute, the following system, which is not novel, but is based upon methods which have been in use on large public works in other countries for more than a generation. The proposed method is as follows: Prior to the letting of any public contract the Division Engineer to prepare a schedule of prices for every unit of work to be used under the proposed contract. This schedule of prices to be submitted to the State Engineer and the Superintendent of Public Works for approval or revision, and when approved by them to be submitted to the Canal Board for final adoption. On the letting of the work each bidder will only be required to bid a discount or premium of a certain per cent. on the prices adopted by the Canal Board. The lowest bidder will be the one offering the greatest percentage of discount or the least percentage of premium on these prices. All questions of quantities will be eliminated from the bidding. It is fair to presume that prices which have been originally drawn up by the Division Engineer, familiar with all the local conditions, subsequently revised and approved by the State Engineer and the Superintendent of Public Works, and finally adopted by the Canal Board (which should have authority to call in outside expert advice, if it saw proper), would be fair and reasonable prices for the work to be done. It would then only remain for the bidder to use his own judgment as to increasing or diminishing these prices by a certain fixed percentage, which should apply to every item in the entire list. We believe that the adoption of such a plan as a part of the law of this State would make it impossible hereafter for contractors to take advantage of the State by means of unbalanced bids.

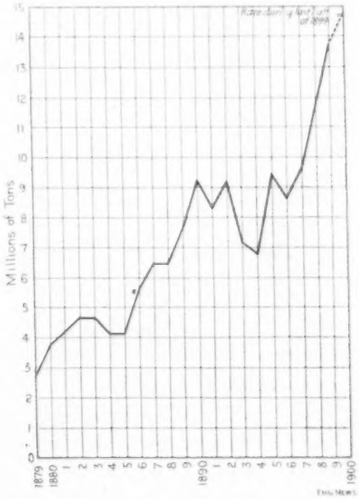
Trusting that the result of our labors during the past year may be of some assistance in enabling you and the Legislature to "formulate definitely the canal policy of the State"—a matter which we consider of vital importance to its commercial and industrial welfare—we remain, very respectfully, Francis V Greene, Chairman; George E. Green, John N. Scatcherd, Thomas W. Symons, Frank S. Witherbee, Edward A. Bond, State Engineer and Surveyor; John N. Partridge, Superintendent of Public Works.

STATISTICS OF PIG IRON PRODUCTION.

The report of the production of pig iron in the United States in 1899 just issued by the American Iron and Steel Association shows the greatest annual increase in tonnage that has ever been known in the history of the trade. The total production was 13,620,703 gross tons, as compared with 11,773,934 tons in 1898, and 9,652,680 tons in 1897. The production in 1897, exceeded that of any earlier year, although figures above 9,000,000 tons had been reached in 1895, 1892 and 1890. The following table shows the tonnage of each year since 1879, and the figures of the table have been plotted in the accompanying diagram:

Year.	Gross tons.	Year.	Gross tons.	Year.	Gross tons.
1879	2,741,853	1886	5,683,329	1893	7,124,502
1880	3,835,191	1887	6,417,148	1894	6,657,388
1881	4,144,254	1888	6,489,738	1895	9,446,308
1882	4,623,323	1889	7,603,642	1896	8,623,127
1883	4,595,510	1890	9,202,703	1897	9,652,680
1884	4,097,868	1891	8,279,870	1898	11,773,934
1885	4,044,526	1892	9,157,000	1899	13,620,703

The production in the first six months of 1899 was 6,289,167 tons, and in the second six months 7,331,536 tons. The consumption of pig iron in the United States in 1899 is estimated to have consid-



Production of Pig Iron in the United States, 1879 to 1899.

erably exceeded the production since there was a reduction of unsold stocks in manufacturers' hands, on the market, from 415,333 tons on Dec. 31, 1898, to only 68,330 tons on Dec. 31, 1899. The latter figure is only half of one per cent. of the year's production or less than two days' production. It is doubtful if this extraordinary condition of shortage was ever before known in the iron trade, or in the trade of any other staple article of commerce.

Much has been said in the last two years concerning the exportation of American pig iron to Europe, but the exports as yet do not exceed 2% of the production, the quantity being estimated at about 230,000 tons. The imports were about 37,000 tons.

Judging the future by the past, it would seem probable that the diagram of production, which has been mounting skyward for over two years, will soon tend toward the horizontal, as it did in the years 1880-85 and 1890-92, but it is not likely that the sharp turn in that direction will take place in 1900. The stocks on hand are too low and the demand too great for us to expect anything else than that the figures for 1900 will show a considerable increase above those for 1899.

THE 8,000-C. P. ELECTRIC LIGHT STATION in Bangkok, Siam, is being operated by an American syndicate under a 25-years' exclusive franchise. It was purchased in 1890 from the English Brush Co. by a Siamese company, but the plant was not operated until 1894, and then met with financial disaster and passed into the hands of the American engineer, Mr. L. E. Bennett. This plant is valued at $200,000 gold, and has been recently sold to a Danish company, and is to be extended and improved. This last company is the Siam Electricity Co., Ltd., says Consul-General H. King, of Bangkok.

IN THE SUIT TO PREVENT THE DISCHARGE of sewage effluent from the filter beds of Summit, N. J., into the Passaic River at a point some 15 or 20 miles above the Paterson water-works intake, Vice-Chancellor Emery has refused to grant a temporary injunction pending the final hearing.

WATER FROM THE CHICAGO DRAINAGE CANAL was discharged through the controlling works at Lockport, Ill., into the Des Plaines River on Jan 17. Water was let into the canal on Jan. 2, as described in our issue of Jan. 11. Some days were devoted to the gradual filling of the canal, while at the same time the Sanitary Trustees were awaiting the certificate of the State Commission and the permission of Governor Tanner authorizing them to send the waters of the Chicago River and Lake Michigan, and the sewage of Chicago, down through the Illinois and Mississippi valleys. The permission came none too soon, for shortly after the bear trap dam at Lockport was lowered the Sanitary Trustees received word that action had been begun in behalf of the State of Missouri, in the U. S. Supreme Court at Washington and the U. S. District Court at Chicago for an injunction to prevent the putting of the canal in use. On Jan. 22 Chief Justice Fuller, of the U. S. Supreme Court, gave leave to file a bill for an injunction, making the bill returnable on April 2. He refused to issue a temporary injunction against the use of the canal pending the determination of the case, on the ground that the court could not "undertake to issue an injunction against a sovereign State without notice."

A STEAMBOAT LOCK in the Mississippi River, in the dam between Rock Island and Benham's Island, opposite Moline, Ill., is proposed, for the purpose of improving navigation and port facilities of Moline. The wing dam for the water power plants of Moline and the Rock Island Arsenal, extends from Benham's Island several miles up the river, and as the east channel between Rock Island and the shore is not navigable, steamers have to go up the main channel, over the rapids and then come back inside the wing dam to the city. With a lock in the short dam between the two islands, this roundabout route would be eliminated, and there would be easy navigation inside the wing dam instead of the passage of the rapids. The cost of the lock, and dredging and blasting the approaches is estsimated at $150,000.

RIVER IMPROVEMENTS IN CANADA will include the improvement of French River, from its mouth on Georgian Bay to Lake Nipissing, as advocated by Mr. J. I. Tarte, Minister of Public Works, Canada. The river is already navigable, but will be made a waterway for ships of 18 ft. draft, in order to carry the large lake steamers from Fort William to North Bay, on the Canadian Pacific Ry., 650 miles, North Bay being 360 miles from Montreal. The length of work on the French River will be 50 miles, and there will be dams, dredging work, and three locks. The Red River, in Manitoba, will be improved by the construction of locks and dams at St. Andrews, 15 miles from Winnipeg, and plans for the work have been adopted. These plans provide for a dam across the river 800 ft. in length, a canal 1,900 ft. in length, one set of locks 215 ft. in length, and dredging in the river for a distance of some 400 ft. The lock will be 215 ft. long, 45 ft. wide, and the concrete granite-faced walls will be 38 ft. deep, giving the locks a high water depth of 30 ft., while at low water the depth will be 11 ft. The gates will be of steel and there will be side sluice culverts for emptying and filling. The approach to the locks will be by a canal on the west bank of the river, a distance of 1,500 ft. The canal will be 45 ft. wide and have a depth of 11 ft. The embankment on either side will be faced with granite. The canal extends with the same dimensions 400 ft. north of the lock to the river, which will be dredged to a depth of 9 ft. for about 300 ft. The dam to regulate the water in the river will extend from the east side of the locks 800 ft. to a point on the east bank of the river. It will be of concrete, granite-faced, and will be at the base 32 ft. in thickness and will gradually taper till at the top the thickness is 18 ft. 5 ins. The dam will be provided with seven piers and two abutments, and also with sluice-gates. The piers and abutments can be used as the base of a service bridge and from this could be worked a system of shutters and moveable frames, by which the height of the dam could be increased 12½ ft. The bridge and shutters are not, however, included in the contract. Bids for this work will be opened Feb. 15. Mr. Z. Malhiot, Resident Engineer of the Public Works Department, at Winnipeg, will be in charge of this work.

THE NEW DRY-DOCKS AT LEAGUE ISLAND and Mare Island are to be changed from timber construction, as authorized by the last Congress, on June 30, 1899, to stone and concrete, under an act passed by the present Congress on Jan. 20. Under this act the total additional cost for the two docks is not to exceed $700,000. While the change is left to the discretion of the Secretary of the Navy, there is no doubt that these two, like the docks under construction at Boston and at Portsmouth, will be stone and concrete. As shown in a letter of Secretary Long to the Naval Committee of the House, the stone and concrete docks, at a little more than $1,000,000 each, are more economical and much safer than the seemingly cheaper timber dry-docks.

THE "HOLLAND" SUBMARINE BOAT has been rejected by the Navy Department. The Holland Company offered to sell the boat for $166,000; or to add certain improvements and to sell for $170,000; or, to build two new and larger boats for $170,000 each. The majority of the Board on Construction rejected these propositions, because the company was already a delinquent in the case of the submarine "Plunger," on which the government had already expended $99,716, with no immediate prospect of completion. If the company makes satisfactory settlement for the "Plunger," the Board would favor a contract for building a larger boat, as proposed; but it would not buy the "Holland." Chief Constructor Hichborn, in a minority report, favored buying the "Holland" and ordering two new boats. There is rumor of another test of this boat before a newly appointed board.

WIRELESS TELEGRAPHY for Channel steamer service is being introduced by the South Eastern & Chatham Railway Co. This company is said to have an arrangement with the Wireless Telegraph & Signal Co. to equip the steamers on the Dover and Calais, and Folkestone and Boulogne service with the Marconi system. This telegraph is to be used for service purposes only, and it will be operated from a mast erected at Dover.

THE SIAM CANAL, LAND & IRRIGATION CO., says Consul-General Hamilton King, of Bangkok, was formed in 1890, under the encouragement of the King. The great alluvial plain of Southern Siam is cut by many canals, built 50 years ago, and connecting the great tidal rivers, flowing almost parallel to each other. The canals served as the only highways until about 10 years ago, but they are rapidly silting up and the above company was organized to improve them. The company has already dug a canal, on the left bank of the Menam, 52½ ft. wide and 35 miles long; several miles south if this canal and parallel to it is another canal, and some distance north of the main canal is a third canal, about 39 ft. wide. At intervals of about 1½ miles cross-canals are cut connecting these three. As a result a tract of waste land, 25 by 35 miles, is being brought under cultivation, and is now occupied by 70,000 people. On the opposite side of the Menam another canal system has been commenced, and as this reclaimed land is sold for $2.75 gold per acre, the reclamation process is very popular with the government and the people. One result is a demand for better agricultural implements, and Mr. King thinks that enterprising Americans could provide tools suitable for this country and make money at it.

GERMAN METRIC CLASSIFICATION of iron manufactures is reported upon by U.S. Consul Hill, of Amsterdam. By this report it appears that the Iron & Steel Manufacturers' Union, of Germany, has adopted a uniform system of dimensions for articles of universal consumption at home or abroad. Angle-iron, for example, is rolled to identical dimensions to the "German normal profiles," with each section designated by a number and letter; the specifications and price-list conform to this marking and tables accompany them giving weights, safe loads on given spans, etc. Flanged boiler ends are made in standard sizes up to 3 m., or 9.843 ft. diameter, raising by 10 cm., or 3.75 ins. for each size. Iron and steel tubes and all fittings connected with them, in flange diameter and working lengths, conform to established standards, so that any piece can be readily duplicated. The subject of a standard metric screw-thread is now being discussed by the German engineers, to supplant the Whitworth thread, which is so differently made that the parts are not interchangeable. Mr. Hill points out the value of this systematic procedure in the extension of foreign trade in metric-using countries.

ARMORED TRAINS, and steam entrenching machinery are the innovations in war extensively employed in the South African campaign. The first were employed in our Civil War to some extent, but they were usually improvised. The African armored trains are supplied by the Birmingham Railway Carriage Co., of England, and are shipped in sections. Each car is plated with ¼-in. Siemens-Martin steel, and is 36 ft. long and 7 ft. 3 ins. wide, the sides are 3 ft. 1½ ins. high, inside, and each is fitted with vacuum and hand-brakes, and weighs about 12 tons. On their arrival in South Africa, upper plates are added, sloping inward and pierced with loopholes for rifles. In addition to some hundreds of these cars already shipped, Fowler & Co. have furnished four powerful traction and winding engines, handling from 500 to 1,000 yds. of ⅞-in. wire rope. These engines are used in steep places and to haul loads over rivers and swamps; they will also be used to operate the powerful entrenching plows.

TOPOGRAPHIC STATE MAPS, made by the United States and State Geological Surveys conjointly, are noted in late bulletins of the U. S. Geological Survey. Of New York 86 atlas sheets are now published, covering practically the whole Hudson River valley and the Adirondacks, the lake shore between Buffalo and Rochester, the east shore of Lake Ontario, and an L in the central part of the state, reaching from Utica to Ithaca. The maps for the state of New Jersey are complete; Delaware Bay is practically covered, and in Pennsylvania the anthracite coal field has been mapped and a small portion of the upper Delaware River. For New Jersey there are 48 atlas sheets; Pennsylvania, 37; and Delaware, 4 sheets. A geologic map of the United States is also in preparation, and the sheets are issued in folios covering certain areas; 51 of these folios are ready for distribution and 13 are nearing completion. The state atlas sheet is 16½x20 ins., with two scales used, of 1 mile and 2 miles to an inch; these sheets are sold for 5 cts. each. The geologic folios referred to are sold for 25 cts. each. By addressing The Director, U. S. Geological Survey, Washington, D. C., index sheets can be obtained showing exactly the parts now mapped, the names of sheets and the separate quadrangles covered by the geologic folios.

THE COST OF MAPPING by the U. S. Geological Survey is given in the following table, the work being on a scale of one mile to the inch, with 20-ft. contours. The cost of such work is estimated at $10 to $15 per sq. mile, or $5 to $8 per sq. mile for a scale of two miles to the inch. The Survey is prepared to undertake this work for other states, the national government bearing half the cost:

State.	Area, sq. miles.	Area mapped, sq. miles.	Total cost.	State appropriation.
Massachusetts	8,315	All.	$107,845	$40,000
Connecticut	4,990	"	48,355	25,000
Rhode Island	1,250	"	11,212	5,000
New Jersey	7,815	"	85,365	40,000
New York	49,110	18,515	216,000	86,000
Maryland	12,210	8,410	35,000	7,000

THE PRICE OF GAS IN NEW YORK has again been reduced from $1.05 to 65 cts. per 1,000 cu. ft. by the New Amsterdam Gas Co., on account of the failure of rival companies to re-establish the former rates.

COMMON SCHOOL STATISTICS OF THE UNITED States are summarized as follows by the U. S. Commissioner of Education in his report for 1897-98, just issued: Total population, 72,737,100; number of persons 5 to 18 years of age, 21,458,294; pupils enrolled on school registers, 15,038,636; or, 20.68% of the total population, and 70.08% of those between 5 and 18 years of age. Number of schoolhouses, 242,390; number of teachers, 409,193; with 32.2% of these male teachers; value of school property $492,703,781. The total receipts for educational purposes were $199,317,597, from state and local taxes, permanent funds and other sources: of this total 67.3% came from local taxes and 17.9% from State taxes. The total expenditures amounted to $194,020,470, or $2.67 per capita of population; the total expenditure per pupil for the year was $18.86. The total number of pupils and students in all grades of both public and private schools, in 1897-98, was 16,687,643; with 6,277,474 of these coming from the North Central division of States, and 4,284,167 from the North Atlantic division. In the above the term common school includes only public schools of elementary grade; it does not include institutions of a higher grade, though State universities, normal and technical schools also draw support from public funds.

MANILA HEMP is produced from the fiber of the "Musa textilis," a plant belonging to the banana family, but distinct from the "Musa edibilis," or that producing the edible fruit of commerce. The plant grows from planted shoots to a height of 10 ft. and is 5 to 7 ins. diameter. It is cut down when 3 years old and stripped of its fiber by native cleaners, another shoot being at the same time planted to take its place. The stalk is stripped of its leaves, and the stout pith in the center is found to be surrounded by alternate layers of fiber and a sappy, vegetable matter. These layers of fiber must be carefully removed at once, to prevent rotting, and dried in the sun; a full tree yields about one pound of fiber in 6 to 8 ft. lengths. This stripping is an exceedingly difficult and important process in the production of the hemp and requires great experience.

THE TRANS-SIBERIAN RAILWAY was opened, on Dec. 28, 1899, from Lake Baikal to Stretensk, at the head of navigation on the Amur River; and, including the Lake Baikal transfer system, the line is now open from St. Petersburg to Stretensk, where connection is made with Pacific coast boats. When the line across Manchuria, from Stretensk to Port Arthur is completed Russia will have a continuous railway—excepting at Lake Baikal, 5,620 miles long—between St. Petersburg and Port Arthur. The line opened, however, is hastily and cheaply built, and must be in great part reconstructed. Many of the bridges are of timber.

BOOK REVIEWS.

ESSAI DES MATIERES TEXTILES.—Methodes et Appareils en Usage. Par J. Persoz, Directeur de la Condition des Soies et Laines de Paris. Paris: Gauthier-Villars. Paper; 7⅝ x 4⅝ ins.; pp. 186; illustrated. 2½ francs (75 cts.); board, 3 francs (90 cts.).

This work is for the use of those interested in the sale or manufacture of textiles. It begins with the several methods of expelling moisture from fabrics by heat, and thus testing their permanent qualities. The second chapter relates to the removal of gum from silks and the washing of linens; and other chapters follow on the valuation by the number of threads per unit, in France and abroad; torsion tests of threads, and tests of tensile strength, or resistance, and the elasticity of the threads and stuffs.

THE SEPARATE SYSTEM OF SEWERAGE.—Its Theory and Construction. By Cady Staley, President of Case School of Applied Science, Cleveland, O., and Geo. S. Pierson, M's. Am. Soc. C. E. Third edition, Revised and Enlarged, with a Chapter on Sewage Disposal. New York: D. Van Nostrand Co. Cloth; 6 x 9 ins.; pp. 324; 38 illustrations and 36 tables. $3.

While the value of this book has been materially increased by the new matter in the present edition, the revision and enlargement is really comparatively small. Some of the data on water consumption are for the year 1884, most of the figures showing the cost of construction are old and no reference is made to the recent valuable additions to our knowledge of sewage disposal nor to the discussions on sewer assessments. The paragraph (p. 201) on the dissemination of disease germs by "sewer gas" should have been stricken out, as it is no longer held by the best authorities that such germs "abound in the warm, moist air of the sewers and are carried wherever the sewer gas penetrates."

Such new matter as the book does contain relates principally to sewer outlets and pumping stations, both of which are only briefly discussed; and to recent experiments or observations on the effect of flush tanks. There are a few valuable additional figures on water consumption. The new matter on flush tanks and water consumption has already been published elsewhere.

Notwithstanding these criticisms, the book continues to be of value. In justice to authors and publishers, it should be remembered that it is a difficult task to keep technical books up to date, without absolute financial loss.

ANNUAL MEETING OF THE AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.

The sixth annual meeting of the above-named Society was held at the house of the American Society of Mechanical Engineers in New York city, on Jan. 23, 24 and 25. About 60 members were registered as in attendance. The first session, held on Tuesday afternoon, Jan. 23, was devoted to regular business. Reports were made by the officers and by the Council and Board of Managers, which showed a satisfactory, though slow, growth of the society, and a hearty interest by the members in its welfare. A new constitution has gone into operation, by which the organization is simplified, a board of "Governors" taking the place of the two former bodies known as the Council and the Managers. The retiring President, Mr. Henry Adams, of Washington, D. C., made a brief address, from which we extract the following:

Since the formation of this Society, the heating and ventilating engineers of other countries have formed societies similar to our own. This demonstrates the constantly increasing importance of our branch of engineering, and the wisdom of combining for the purpose of advancing the arts and sciences in connection with it.

To-day the necessity for proper warming and ventilating of all classes of buildings is being more generally recognized than ever before. Much more, however, remains to be done, and the continued earnest efforts of each individual member will be required to finally attain the high standards and ideals of our Society. This is especially the case with compulsory legislation; and in this matter I would request each member to make an effort in his own locality towards obtaining suitable legislation, in which efforts he will have the assistance of the committee having this in charge.

The transactions of our Society to-day form a most valuable part of the available heating and ventilating literature which is printed in the English language.

I hope that the Society will soon be able to begin publishing a small monthly bulletin for the benefit of our members.

Before closing my remarks I cannot refrain from mentioning a subject which so far has received little attention from the Society, although it is of great importance; namely, the proper supervision and operation of heating and ventilating apparatus, especially in larger buildings. During my experience I have had frequent opportunity to examine work which was reported unsatisfactory, but upon inspection was found well designed and executed, being inoperative solely through incompetent attendants. I have found this especially the case in schools and other public buildings where the men in charge were entirely ignorant of the functions of any appliances under their care. To remedy such conditions, I consider, should also be an aim of the Society.

Reports of the Committees on Tests and Standards and on Compulsory Legislation were read and discussed, after which the session adjourned.

At the evening session the tellers reported the election of the following officers for the ensuing year: President, D. M. Quay; 1st Vice-President, A. E. Kenrick; 2d Vice-President, F. A. Williams; Secretary, Wm. M. Mackay; Treasurer, J. A. Goodrich; Governors, R. C. Carpenter, John Gormly, C. J. Snyder, D. M. Nesbit and Wm. Kent.

A paper on "Neglect of Ventilation in Some Hospitals" was then read by Mr. Thomas Barwick, in which some remarkable examples of bad design and serious neglect and misuse of hospital apparatus were related.

After some discussion of this paper Mr. John Gormly read a paper entitled, "Dangerous Air Ducts," of which the following is a brief abstract:

The writer has noticed many things which appeal strongly in protest against a present custom, which if not contrary to legal enactment should speedily be so classed.

In such cities as New York it is not uncommon to see the intake shaft of a ventilating apparatus within the danger zone of the fresh-air inlet to a drainage system. Yet the "fresh-air inlet," so called, is frequently an outlet for drainage air. In fact, there is usually no other outlet for such drainage air as may be between the curb trap, as established by law, and the end of a soil-pipe branch, we will say, on the tenth floor of a modern building.

The writer was required a short time ago to report upon the heating and ventilating apparatus used in schools. In that tour of duty he frequently noticed wrapping paper, rags, twine, hair, dust, and other foreign matter in considerable quantities lodged in the wire screens of air-intake shafts of the schools. These could readily have been contaminated with disease germs before entering the air shafts.

Many buildings of moderate size are supplied with air through gravity systems of heating, by hot-air furnace, indirect steam, or water circulation. Frequently in such plants the air ducts are constructed of bricks or tiles and are located beneath the basement floor.

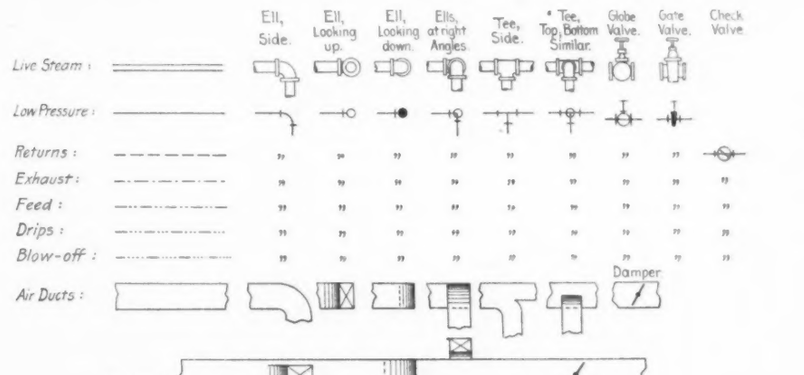
In this form of duct, if sufficient care be not exercised to make the duct gas and air tight, a danger arises that injurious gas from decomposing matter may find access to the interior of such ducts and thence be disseminated throughout the entire building.

The writer knows many blocks of dwellings supplied with air through very poorly constructed ducts, upon land which, for many years, was a burying ground for human beings. Thousands of houses are erected on land graded on swamps with the offscourings and refuse of our large cities. An air duct under ground in such a location should be absolutely air tight and so constructed that it would remain air tight for ages.

The ventilating engineer must look with suspicion upon drainage pipes traversing his ducts or in proximity thereto. The writer, in two recent cases, found sewage in the air ducts of dwellings because of defective drains and ducts in proximity.

A long and interesting discussion followed the reading of this paper, and many horrible examples of dangerous ducts were cited.

On Wednesday morning the members met in a body at the Park Row building for the purpose of inspecting the heating, electrical and mechanical apparatus of the tallest office building in the world. Among the features which attracted especial attention were the ample space and head room provided in the boiler, engine and dynamo rooms; the vertical screw, Sprague electric elevators, remarkable in their economy of ground space; an ice-making plant and a steam laundry in operation in the cellar; and the Paul system of steam heating, in which a vacuum of 5 ins. of mercury is maintained throughout the direct radiation system of the building.



PROPOSED STANDARD SIGNS FOR USE IN MAKING WORKING DRAWINGS OF HEATING AND VENTILATING SYSTEMS.

The meeting on Wednesday afternoon was devoted to the reading and discussion of papers and "topics for discussion." The first paper was by Prof. R. C. Carpenter, on "Methods of Testing Blowing Fans." The discussion related chiefly to the great sources of error of the measurement of air flowing in tubes or discharged by fans. The next paper was by Mr. H. Eisert, entitled "The Calculation of Disc Fans." This was a highly mathematical and theoretical paper, which may be appreciated by designers of fans, but it was rather too deep for the members to discuss offhand. The practical part of the paper, which shows that there is a great deal yet to be learned about the capacity and efficiency of disc fans, is given in the following extract:

Many experiments and tests have been made by various experimenters with disc fans of different constructions, and, as it was to be expected, with greatly varying results. But notwithstanding this seemingly discouraging fact, all of these tests without exception can be compared upon one common basis, whereby such practical data can be obtained as will prove of great value for the calculation of disc fans, as well as for the proper judgment of the actual performances of such fans in operation.

The results from all actual tests demonstrates the unfavorable effect of the "back-lash" or "slip" of the air upon the delivering efficiency of the disc fan whenever discharging against a resistance. This "back-lash," or "slip," of the air in a disc fan is a relative measure for that part of the air that is being discharged at the periphery of the fan at its inlet side, and naturally varies with the construction of the fan and the form of its blades. There is no back lash perceptible when a fan delivers at free discharge, but it appears as soon as the air is delivered against a resistance, and increases with the offered resistance, reaching a maximum when the fan delivers into a closed receptacle, or when its outlet is closed. In the latter case, when the air delivery should be zero, a rapid circulation of air takes place within the fan, independent of the fan movement, the air entering near the center and leaving at the periphery on the inlet side. Under such conditions it cannot be expected that a disc fan should ever produce the maximum air pressure corresponding to its circumferential velocity whenever discharging against a resistance. The difference will be the greater the less the actual air delivery of the fan, as compared with its delivering capacity at free discharge for the same number of revolutions. This disadvantageous property of the disc fans excludes them from practical application for the movement of even small quantities of air against extreme resistances. For the movement of large volumes of air against very low resistances, however, this type of fan will always be the most economical as to the required power, and not less convenient as to its adaptability to local conditions. In connection with ventilating plants disc fans are especially preferred for exhausting purposes, and that with right, inasmuch as the resistances to the flow of the air are usually extremely low, rarely exceeding ¼-in. water pressure, a limit up to which the unfavorable effect of the back-lash can be neglected and the proposed formulas for the calculation of the probable performances of disc fans applied with perfect safety for all practical purposes.

The first "topical discussion" was upon the question, "What is the best and most practical method of heating and ventilation for hospital wards?" The replies were generally to the effect that it depends on the hospital, and on the amount of money appropriated. No one method can be called the "best." One method may be more suitable for one set of conditions and another for another.

The next topical question was: "Is there a recognized system of symbols for the marking of drawings, for the designation of pipes, ducts, etc? If not should not a sign language be adopted for the interpretation of drawings." The replies were to the effect that there is no "recognized" system; each drawing office uses its own system; and that a sign language should be adopted. Mr. Thomas Barwick exhibited a roll of drawings in which a definite system of symbols was used, and he explained the system, which we reproduce in convenient form herewith.

At the meeting on Thursday morning the first paper was by Prof. Carpenter, entitled "Condensation of Steam in Blower Systems of Heating." This was a detailed record of what is probably the most complete series of experiments in heating of air by steam coils, in the blower system, that has ever been published. We give the most important portions of his paper elsewhere in this issue. The discussion of this paper was followed by a brief paper by Mr. Albert A. Cary, on "The Removal of Dust from Boiler Rooms." This paper describes an ingenious method of treating a difficult problem, and we shall reprint it later in these columns. The discussion dealt chiefly with the difficulties of dust removal in general.

Topical discussions were then taken up as follows: "When heating by direct radiation, should the radiators be placed close to an outside or an inside wall? And if placed on an outside wall should they be placed between or before the windows?" The participants in the discussion were unanimously of the opinion that the outside wall was the proper location, and instances were given of improvement in heating and in stopping of cold drafts along the floor due to removing the radiators from an inside to an outside wall. As to their location before or between the windows, there seemed to be some difference

of opinion, but the preference was generally given to placing them before the windows.

The next question was, "When testing radiators, what should be considered the maximum allowable error in any one test of a series?" The discussion of this topic largely had reference to the meaning of the word error. The allowable error of measurement of condensed steam, and of temperatures, was stated to be not over half of one per cent.; but the error in measurement of the quantity of air heated might easily be 30% or 40%, and the error in the determination of the efficiency of the radiator might be as great, since in ordinary radiator tests it is not possible to make the conditions of the tests uniform. Methods of making the conditions uniform were suggested, such as enclosing the radiator while being tested in an air-tight tank with hollow walls, the space between the walls being filled with water of a known temperature.

At the last session, held on Thursday afternoon, a paper was read by Mr. James Mackay on "The Rating of Steam and Hot Water Boilers for Heating Purposes." After some discussion of this paper the remainder of the session was taken up in discussion of the following topics:

"Does the present construction of large buildings with curtain walls, made of hollow brick and plastered, conserve the heat as well as solid brick walls, furred, lathed and plastered?"

"In heating factories, is it wise to use only direct radiation without ventilation, or would it be better to use a forced circulation of warmed air?"

"What is the most efficient and economical manner of taking care of drips from steam systems where the condensation is not returned to the boiler by gravity?"

"Cannot a schedule be devised for the proper ventilation of toilet rooms in public buildings, doing away with deodorizing appliances?"

The discussion of these questions was kept up for some time, but without adding much to the store of knowledge concerning them. The programme being thus finished, the meeting adjourned.

The social event of the meeting was a dinner on Wednesday evening at the "Arena," which was attended by about 60 members and invited guests.

ANNUAL MEETING OF THE ILLINOIS SOCIETY OF ENGINEERS AND SURVEYORS.

The fifteenth annual meeting of the Society was held at Moline, Ill., Jan. 24, 25, 26, the headquarters being at the Sommers Hotel, and the meeting being held in Vorwaert's Hall and at the City Hall. The first meeting was called to order at 2 p. m., Jan. 24, the President, Mr. A. D. Thompson, City Engineer of Peoria, being in the chair. An address of welcome was delivered by the Mayor, Mr. P. H. Wessel, who briefly referred to the great achievements of engineering during the 19th century, and to some of the most important of their works, including with some remarks upon the engineering works in the vicinity of Moline and Rock Island. The President then delivered the annual address, taking for his subject the relation of the engineer to professional organizations. In this he showed the advantages of membership in such organizations, to the members themselves and to the profession at large. He also referred to the large body of members who fail to do their part, in that they fail to present or discuss papers and object to serve on committees, or otherwise assist in promoting the interests of the profession and the organizations. He also stated that the Illinois Society now has a deficit of $85, and that some action must be taken towards improving the financial conditions. The report of the Secretary and Treasurer, Mr. Jacob A. Harman, of Peoria, showed that the receipts for the past year amounted to $588, while the expenditures were $623. The Society now has 81 members, exclusive of those elected during the meeting.

A paper on "A State Municipal Work Commission" was then read by Mr. C. C. Brown, of Bloomington, Ill. In this paper he advocated the organization of such commissions to exercise a supervisory and advisory control over municipal public works, and especially to prevent the carrying out of the badly planned works sometimes advocated by incompetent local authorities. As arguments in favor of such a system he referred to the satisfactory results obtained from the Metropolitan water supply and sewerage commissions in Boston, the State Highway commissions of Massachusetts and Connecticut, the State Board of Health in various States, the Sanitary District of Chicago, and the Local Board system of Great Britain. In the discussion, Mr. D. W. Mead, of Chicago, objected to any such system of State interference with municipal affairs, and in regard to the political side of the question he thought municipal legislators would compare favorably with State legislators. If there is to be any such interference or regulation, it should be by a national rather than a State body. The proper steps, in Mr. Mead's opinion, would be to promote the education of municipal legislators in matters referring especially to public health.

Mr. Harman then exhibited a number of maps illustrative of the work of the U. S. Geological Survey, and presented a statement from an officer of the survey giving the estimated cost of mapping as $10 to $15 per sq. mile for a scale of 1 mile to the inch, or $5 to $8 per sq. mile for 2 miles to the inch. The survey is prepared to undertake this work for any State, the national government bearing half the expense.

Mr. Edward Kittilsen, City Marshal of Moline, then read a paper on "Garbage Collection," in which he described the development of the system now in use in that city, which consists in the collection, removal and burying of all garbage by the city, the horses, carts, tools, etc., being all owned by the city. There was very little discussion on the paper, and it was followed by a brief discussion on "Form of Cross Sections and Width of Roadway for Public Highways."

At the evening session Mr. D. W. Mead presented a short report from the Committee on Sanitary Legislation. The bill approved by the Society and pushed by the committee passed the House but was killed in the Senate of the State legislature. Nevertheless, it is thought that by continued work such a bill can be passed, and the committee was continued to prosecute this work. The report of the Committee on Drainage was read by Mr. J. L. Clark, showing that 2,100 miles of tile drains were laid in 1899, as against 1,800 miles in 1898, all in the northern and central portions of the State. Reference was also made to the inefficiency of much of the work done by the "practical tiler." In dredging for drainage work about $110,000 were spent in 1899, as against $160,000 in 1898. The "Big Four" drainage district in Ford county will have a canal 23 miles long and 9 ft. deep, requiring 1,500,000 cu. yds. of excavation, and costing $125,000. The engineer is Mr. L. H. Sizer, of Champaign, Ill. The report stated that 3 ins. per 100 ft. should be the maximum grade on tile drains. In the discussion on this report, and on the topical subject of "What Capacity per Acre Should be Provided in Pumping Plants for Drainage Districts" Mr. D. W. Mead referred to the drainage pumping plants in Illinois and in the Sacramento Valley, California. In a district of 8,000 acres in Illinois, the pumping plant has a capacity of 3 gallons per acre per minute, or 1½ gallons for the entire area draining into the district. Mr. Clark uses Fanning's formula for large districts, but in small districts one-tenth of the result obtained is sufficient. Mr. E. E. Johnson pointed out that the question depends largely on the character of the topography and the subsoil, and that no formula or rule can be universally applied, the skill of the engineer being required to determine the matter in each case.

The City Engineer of Moline, Mr. H. G. Paddock, then read the report of the Committee on Land and City Surveying, the main point of which was that the influence of the Society should be exerted towards effecting the passage of a practical law for the licensing of surveyors. This was followed by the reading of a humorous letter from Mr. J. R. Jaffray, of Belvidere, Ill., on "The Re-Surveyor." A brief discussion on the setting of monuments then took place, after which a paper on "Land Marks," by Mr. J. Foster Schmeltzer, of Mantino, was read. This also referred mainly to the question of monuments and corners, and described different styles of corners. One of the best was said to be a medium sized boulder set 14 ins. below the surface, and having a 5-in. drain tile set upon it, the tile being packed inside and out with broken stone. The tile wears away gradually, but it can easily be located. Concrete blocks were also suggested.

On Thursday, Jan. 25, the meeting was called to order at 8:45 a. m., and Mr. W. C. Holbrook presented a paper entitled, "An Examination of Recent Supreme Court Decisions of Interest to Surveyors and Civil Engineers." This brought out some discussion on certain problems met with in land surveying in connection with property rights and riparian rights.

Prof. A. C. Talbot, of the University of Illinois, then presented the report of the Committee on Paving Brick Specifications and Tests, which brought out a brief discussion as to the importance of uniform standard tests. The report of the Committee on Water-Works was then presented by Mr. C. C. Brown, describing the covered reservoirs at Attica, Ind., and Delphi, Ind., and giving statistics of the cost of pumping in five Illinois towns. The description of the reservoirs was written by Mr. W. D. Shields, of Chicago.

The meeting then adjourned, and the party started on an excursion, visiting first the water power and electric plant of the Moline Water Power Co., which has 12 wheels developing 150 HP. each. There will eventually be 30 wheels, and current will be supplied for lighting, railway and factory power purposes in Moline, Davenport and Rock Island. A special train on the new Davenport, Rock Island & Northwestern Ry. then took the party over the new Mississippi River bridge (Eng. News, Jan. 18, 1900) to Davenport, where lunch was served at a restaurant. Electric cars then took the party over the double deck railway and highway bridge to the U. S. Arsenal on Rock Island, where the government now manufactures gun carriages, saddlery, harness, canteens, haversacks and other equipment. It is proposed to install an extensive small-arms factory. The machinery is operated by rope transmission from a water power plant, but the power is to be utilized for an electric plant to operate all the machinery. From the arsenal, carriages took the party to the site of the proposed steamer lock, to enable vessels to reach Moline without going round the long wing dam which extends some miles up the river. Thence they proceeded to the extensive works of the Moline Plow Co., and then to the garbage washer and dump, to see the system devised by Col. Kittilsen in operation. The party then returned to the hotel.

The evening session was held in the Council Chamber of the City Hall. The report of the Committee on Railways was presented by Mr. E. E. Russell Tratman, Associate Editor of Engineering News, and this discussed three questions: (1) The permanent improvement works now being carried out by American railways; (2) the use of concrete instead of masonry for bridge piers and abutments; (3) the education of young men for the civil and mechanical engineering departments of railway service. Mr. J. C. Quade, City Engineer of Kewanee, Ill., then read a paper on "The Construction of the Kewanee Sewerage System," showing, among other things, that all house laterals were built up to the property line when the sewers were built, thus preventing the tearing up of streets for putting in laterals. The cost is assessed on property holders. The inspection of the work amounted to 8% of the total cose. The paper was followed by some discussion on sewer construction, and the entrance of subsoil water into sewers. A short topical discussion on "The Best Method of Indexing Maps and Drawings" was then opened by Mr. A. D. Thompson, City Engineer of Peoria, who described the system in use in his own office.

The election of officers was next proceeded with, and resulted as follows: President, C. C. Brown, Bloomington, Ill.; Vice-President, H. G. Paddock, City Engineer of Moline; Trustees, A. D. Thompson, D. W. Mead and J. G. Melluish. Later in the meeting the Executive Committee elected Mr. M. S. Ketchum, Assistant Professor of Civil Engineering at the University of Illinois, Champaign, as Secretary and Treasurer. The city of Bloomington was selected as the place for the next meeting, in 1901.

Two railway papers were then presented: "Improvements on the Chicago, Burlington & Quincy R. R.," by E. P. Chapin, Assistant Engineer, C., B. & P. R. R.; and "Improvements on the Illinois Central R. R.," by Mr. W. E. Angier, Assistant Engineer, Ill. C. R. R. Abstracts of both of these appeared in our issue of Jan. 25.

On Friday the Society met about 8:45 a. m., and Mr. M. S. Ketchum presented a paper on "Commercial Engineering," discussing the qualities required for a successful engineer from a commercial as well as a professional point of view. This was followed by a paper on "Municipal Ownership of Combined Electric Light and Water Works Plants," by Mr. Louis E. Fischer, City Engineer of Paris, Ill., in which such ownership was advocated. Mr. A. D. Thompson, however, pointed out that the water rates of Detroit, which had been used as an argument, could not properly be used, owing to the peculiar system on which they were based under Mayor Pingree's desire to furnish water free. While a city should control its water supply system, for reasons of public health, it did not follow that it should control its lighting plant. In small towns a company might often supply neighboring towns and villages, which it would be difficult to do with a municipal plant. The Executive Committee then presented its report, and in accordance with its suggestions it was voted to reduce the secretary's salary (on account of the financial condition of the Society) and to establish a grade of Associate Member for representatives of dealers in supplies and materials used in engineering work.

Three more railway papers were then presented, as follows, but owing to lack of time there was no discussion: "Education in Railway Engineering at the University of Illinois," by E. C. Schmidt, Instructor in the Railway Mechanical Engineering Department; "The Construction of the St. Louis, Peoria & Northern Ry.," by F. G. Jonah, Engineer of Maintenance of Way, Chicago & Alton R. R., and "Economic Railways in Country Districts," by E. E. Russell Tratman, Associate Editor of Engineering News. The second paper showed that the line in question cost $12,400 per mile, complete. The third paper showed that steam railways have actually been built in this country for $2,300 per mile, while light electric railways cost at least $10,000 per mile, including the wiring, power plant, etc.

The next paper was on "Some Uses of the Steam Indicator," by Mr. E. E. Johnson, of Chicago, and this was discussed at some length by Mr. D. W. Mead, of Chicago, who also presented a paper entitled, "Notes on Electric Light and Power Distribution." Prof. A. N. Talbot read a paper on "Sewage Disposal," discussing the general aims of disposal systems and referring particularly to the plant at Madison, Wis. (Eng. News, Dec. 28, 1899), and to the septic-tank system. Mr. J. G. Melluish then presented the report of the Committee on Exhibits (notes as to which are given in the supplement), and a memorial in regard to deceased members. Mr. E. E. Russell Tratman presented the report of the Press Committee. Resolutions of thanks to the various entertainers were then adopted, and also a resolution in favor of the proposed steamboat lock to improve the navigation of the Mississippi River and the facilities of the harbor of Moline, which is now shut in by the long wing dam. The Society finally adjourned about noon, after a busy and successful convention.